ADVANCES IN ZOOLOGY

PROCEEDINGS OF THE FOURTH REFRESHER COURSE IN ZOOLOGY

10th December, 1998 to 2nd Jaunuary, 1999

Jt. Editors
Prof. Amal Bhattacharyya
Prof. Buddhadeb Manna

DEPARTMENT OF ZOOLOGY & ACADEMIC STAFF COLLEGE
UNIVERSITY OF CALCUTTA
35 Ballygunge Circular Road
Calcutta 700 019
Tel # 475-3681

ADVANCES IN ZOOLOGY

PROCEEDINGS OF THE FOURTH REFRESHER COURSE IN ZOOLOGY CALCUTTA UNIVERSITY

CONTENTS

	Page No.
Preface	i
Course Programme	ii - x
List of Resource Persons	xi - xv
List of Participants	xvi - xvii
Course Deliberations - Abstracts of Lectures delivered by Resource Persons	1 - 234
Abstract of Seminar Lectures of Participants	235 - 271
Author Index	272 - 273

PREFACE

The Department of Zoology and Academic Staff College of the University of Calcutta have organized the Fourth Refresher Course in Zoology during the period, 10th December 1998 to 2nd January 1999 with a new focal theme, 'Advances in Zoology'. This programme is sponsored by the University Grants Commission, New Delhi. Similar to three previous courses this was also meant to provide the teacher participants with new information which will help them in teaching and research. Thirty teacher participants were selected for the course and eventually twenty one of them could get the release from the respective colleges and joined the course. Our course attracted persons from outside of our state and we have participants from Orissa, Madhya Pradesh, Andhra Pradesh. The resource persons are invited from various fields of Zoology to deliver lecture of their specialisation and the topics on Biodiversity, Ecology, Environment, Cell Biology, Molecular Biology, Genetics, Endocrinology, Parasitology, Immunobiology, Entomology, Aquaculture, Fishery, Taxonomy, Evolution.

Our honourable Vice-Chancellor Prof. R..N. Basu stressed the need to study different aspects of Biotechnology and its application at the moment. Professor S.C. Bose, Dean, Faculty of Science and Prof. P.L. Majumder, Honorary Director, Academic Staff College highlighted the need of participant to get more involved in the course and generate further knowledge inorder to disseminate the same updated knowledge to their pupils at college level. Dr. M.K. Sengupta, Secretary, University College of Science and Technology pointed out the need of life science study in the present society.

We maintain the spirit of the Department of Zoology and inspite of financial constraints we have compiled the extended abstracts of all the topics of resource persons in the form of a book. We have also included the abstracts of seminar lecture of the participants in the proceeding.

We take great pleasure to thank all the teaching and non-teaching members of the Dept. of Zoology, Calcutta University, who cooperated with us to make this endeavour a grand success. We are extremely indebted to Professor D. Roychoudhury, Head of the Dept. of Zoology for his co-operation during this course work.

We sincerely hope that our dear teacher participants will bear with our limitations and overlook our faults and limitations during these three weeks.

JCU 1196

ADVANCES IN ZOOLOGY

Fourth Refresher Course

Department of Zoolog, & Academic Staff College, University of Calcutta

10th December, 1998 to 2nd January, 1999

10.12.98 Thursday

9.30 A.M. to 10.30 A.M. : **Registration of Participants**

10.00 A.M. : **Inaugaration Session**

1.00 P.M. : **Tea Break**

2.00 P.M. : **Prof. A.S. Mukherjee**
Department of Zoology, University of Calcutta.
Title : Transcription factors and Strategy in regulating sex determination and dosage compensation in *Drosophila* and Mammals.

3.30 P.M. : **Prof. Amalesh Chaudhury**
Department of Marine Science (Retd.), University of Calcutta.
Title : Human impacts on coastal-marine ecosystem and its Biotic Resources : an overview with special reference to Deltaic Sunderbans.

12.12.98 Saturday

11.00 A.M. : **Dr. Asoke Kumar Das**
Deputy Director, Zoological Survey of India, Calcutta.
Title : Integral coastal Management in theory and practice with special reference to South Asian Regional seas.

12.30 P.M. : **Prof. S.G. Pal**
Department of Zoology, University of Calcutta.
Title : Lessons from Golgi discoveries.

2.00 P.M.: **Prof. T.N. Ghosh**
Department of Protozoology (Retd.), Calcutta School of Topical Medicine
Chittranjan Avenue, Calcutta.
Title : Biology and Behaviour of Malaria Parasites.

3.30 P.M. : **Dr. Samar Chakrabarty**
Department of Zoology, University of Burdwan, Golapbag, Burdwan.
Title : Cancer - a mutation driven process.

14.12.98 Monday

11.00 A.M. : **Prof. Bireswar Banerjee**
Department of Geography (Retd.), University of Calcutta.
Title : Ecology and World distribution of animals.

12.30 P.M. : **Prof. J.N. Rudra**
Department of Zoology (Retd.), Presidence College, Calcutta.
Title : Teaching-Learning Process.

2.00 P.M. : **Dr. Biswatosh Sengupta**
Jt. Director, CMDA, Planning Division, Unnayan Bhavan
4th Floor, Salt Lake, Calcutta - 700 091.
Title : Computer and Biostatistical analysis.

3.30 P.M. : **Dr. Samiran Chakraborty**
Department of Zoology, University of Kalyani, Kalyani
Title : Co-evolution in insect plant association.

15.12.98 Tuesday

11.00 A.M. : **Prof. D.N. Jana**
Director of Research, Extension & Farms,
West Bengal University of Animal and Fishery Sciences
68 Kshudiram Bose Sarani, Calcutta 700 037
Title : Sustainable Management of Animal Resources to Enhance Productivity.

12.30 P.M. : **Prof. Madhusudan Ghosal**
Department of Zoology, University of Calcutta.
Title : O_2-CO_2 transport a physiological symbiosis.

2.00 P.M. : **Prof. N.C. Datta**
Department of Zoology, University of Calcutta.
Title : Biodiversity and sustainable development in an ecological perspective - An overview.

3.00 P.M. : **Prof. Timir Baran Samanta**
Department of Microbiology, Bose Institute,
P1/12, CIT Scheme VIIM, Calcutta 700 054.
Title : Microbial model for mammalian drug metabolism and environmental pollution control.

16.12.98 Wednesday

10.15 A.M. : **EVALUATION-1,2**

11.00 A.M. : **Prof. S.P. Mukherjee**
Department of Statistics, University of Calcutta.
Title : Statistical methods for taxonomy.

12.30 P.M. : **Prof. Shelly Bhattacharyya**
Department of Zoology, Viswa Bharati, Santiniketan-731 235.
Title : Signal Transduction Mechanisms in the Stress Response of Hepatocytes.

2.00 P.M. : **Prof. D.P. Haldar**
Department of Zoology, University of Kalyani.
Title : Some aspects of the newly revised classification of the protozoa.

3.30 P.M. : **Prof. N.B. Chatterjee**
Department of Zoology, University of Calcutta.
Title : Application of Biotechnology for sustainable agriculture : Integrated Pest Management.

17.12.98 Thursday

10.15 A.M. : **EVALUATION-3,4**

11.00 A.M. : **Dr. Subir Ghosh**
Member, Wetland Sub-Committee
12.30 P.M. WWF-India (Eastern Region).
Title : Wetland resources for human sustenance : A case study from West Bengal.

12.30 P.M. : **Prof. S.P. Bhattacharyya**
Professor of Zoology, University of Kalyani.
Title : Ovulation — induction and suppression.

2.00 P.M. : **Dr. Goutam Chandra**
Department of Zoology, Univeristy of Burdwan, Golapbag, Burdwan.
Title : Filariasis and mosquito.

3.30 P.M. : **Dr. Pradeep Das**
Assistant Director, Department of Microbiology,
National Institute of Cholera and Enteric Diseases,
P-33 CIT Road, Beliaghata, Calcutta-700 010
Title : Emerging Enteric Parasite of Man : Cryptosporidium.

18.12.98 Friday

11.00 A.M. : **Prof. J.N. Rudra**
Department of Zoology (Retd.), Presidency College, Calcutta.
Title : Integrated study of comparative functional anatomy in the perspective of Advances in Zoology.

2.00 P.M. : **Dr. Birendra Nath Bhattacharyya**
Department of Zoology (Retd.), Bangabasi College, Calcutta.
Title : Early history of vertebra formation and structure of the spinal column in birds.

3.30 P.M. : **Prof. Keshab Mookerjee**
Department of Zoology (Retd.), Asutosh College, Calcutta.
Title : Fishery Management : Today and Tomorrow - an Introspection.

19.12.98 Saturday

10.15 A.M. : **EVALUATION-5,6**

11.00 A.M. : **Prof. (Mrs.) Malaya Gupta**
Department of Pharmaceutical Technology, Jadavpur University, Calcutta-700 032.
Title : Transport across the membrane and the absorption of drug.

12.30 P.M. : **Prof. B.R. Maiti**
Department of Zoology, University of Calcutta.
Title : Demonstration : Microtomy Microscopy & Surgery.

2.30 P.M. : **Prof. Bikas Chandra Pal**
Department of Zoology, Centre for Life Sciences, North Bengal University.
Title : Some Behavioural Aspects of Sexual Selection.

21.12.98 Monday

11.00 A.M. : **Dr. Ashis Ghosh**
Former Director, Zoological Survey of India, Calcutta.
Title : Biodiversity Conservation.

12.30 P.M. : **Dr. Ashis Ghosh**
Former Director, Zoological Survey of India, Calcutta.
Title : Agenda twenty one.

2.00 P.M. : **Prof. D.K. Nanda**
Department of Zoology, Univeristy of Calcutta.
Title : Convoy of neurocrine element in some invertebrates and their implications.

3.30 P.M. : **Prof. J.J. Ghosh**
Department of Biochemistry (Retd.), Univeristy of Calcutta.
Title : Impact of genetics on the history of twentieth century Biology.

22.12.98 Tuesday

10.15 A.M. : **Evaluation-7, 8**

11.00 A.M. : **Sri Pranabesh Sanyal, IFS,**
Chief Environment Officer, Department of Environment,
Govt. of West Bengal.
Title : Natural Resource Management.

12.30 P.M. : **Dr. S. K. Bhattacharyya**
Director, National Institute of Cholera and Enteric Diseases, Beliaghata, Calcutta.
Title : Management of acute diarrhoea.

2.00 P.M. : **Prof. Sujit Dasgupta**
Department of Zoology (Retd.), Presidency College, Calcutta.
Title : Arthropods and our skin afflictions.

3.30 P.M.: **Prof. Tapan K. Banerji**
Department of Anatomy & Neurosciences
University of Texas, Medical Branch, Texas, USA.
Title : Basic Concepts of Hormones and Endocrine glands and the pituitary gland.

23.12.98 Wednesday

10.15 A.M. : **Evaluation-9, 10**

11.00 A.M. : **Dr. Swadesh Dattagupta**
Indian Institute Chemical Biology, Calcutta.
Title : Mammalian Cell Culture : A brief outline.

12.30 P.M. : **Prof. N.C. Datta**
Department of Zoology, Univeristy of Calcutta.
Title : Biomonitoring of aquatic pollution.

2.00 P.M.: **Prof. Amar Nath Bhaduri**
Indian Institute of Chemical Biology,
4, Raja Subodh Mullick Road, Calcutta-700 032.
Title : Biological membrane and signal transduction.

3.30 P.M.: **Dr. P.K. Sen Sharma**
Former Director, Dehra Dun Forest Research Centre, Dehra Dun.
Title : Socio biology of termites.

24.12.98 Thursday

11.00 A.M. : **Prof. Amar Nath Bhaduri**
Indian Institute of Chemical Biology, Calcutta-700 032.
Title : Biotechnology : Science, Application and Future - An Indian Perspective.

12.30 P.M. : **Dr. R.N. Chatterjee**
Department of Zoology, Univeristy of Calcutta.
Title : Evolutionary Origins of Dosage Compensation : An overview.

2.00 P.M. : **Dr. Manas Ranjan Roy**
Chittranjan National Cancer Institute, Calcutta.
Title : Current understanding in the genesis and treatment of human leukemias and lymphomas.

3.30 P.M. : **Prof. Satipati Chatterjee**
Dean, Home Science, Department of Physiology, Univeristy of Calcutta.
Title : Hypertension - causes and remedies.

26.12.98 Saturday

10.15 A.M. : **EVALUATION-11, 12**

11.00 A.M. : **Prof. Sanjib Chakraborty**
Professor of Zoology, Kalyani University, Kalyani.
Title : Hormonal Control of Insect Pests : Prospect.

12.30 P.M. : **Prof. Dipak Ranjan Mandal**
Principal, Bidhan Nagar Govt. College, Salt Lake City, Calcutta.
Title : Defence against intestinal nematodes.

2.00 P.M. : **Dr. Amal Kumar Bandyopadhyay**
Professor of Helminthology (Retd.), Calcutta School of Tropical Medicine, Calcutta.
Title : Helminth man interaction & treatment.

3.30 P.M. : **Dr. Kamalesh K. Misra**
Department of Zoology, Rishi Bankim Chandra College, Naihati.
Title : Topology of Evolutionary Structure and *Urgleichung*.

28.12.98 Monday

10.15 A.M. : **EVALUATION-13, 14**

11.00 A.M. : **Dr. Gourisankar Sa**
Dept of Animal Physiology, Bose Institute, Calcutta.
Title : Selective Induction of Apoptosis in Cancer cells.

12.00 P.M. : **Prof. Giridhari Majumder**
Dept. of Zoology, Burdwan University.
Title : On some aspects of Calssical Taxonomy.

2.00 P.M. : **Prof. A. Nandy**
Dept. of Protozoology, Calcutta School of Tropical Medicine.
Title : Leishmaniasis: A Challenge.

3.30 P.M. : **Dr. Tapan Kumar Pal**
Dept. of Zoology, Vivekananda College, Thakurpukur.
Title : Some aspects on the regulation of gene expression.

29.12.98 Tuesday

10.15 A.M. : **EVALUATION-15, 16**

11.00 A.M. : **Prof. Amitava Nandy**
Dept. of Protozoology, Calcutta School of Tropical Medicine.
Title : Current status of malaria and its control.

12.30 P.M. : **Dr. M.L. Bhowmik**
Principal Scientist and Officer-in-Charge, Regional Research Centre,
Central Institute of Freshwater Aquaculture (ICAR),
Kalyani-741 235, West Bengal.
Title : Sewage-fed aquaculture and associated problems.

2.00 P.M. : **Mr. K.D. Mukherjee**
Apiary & Beeking Co-operative, Baruipur-743 302.
Title : Sustainable Apiculture through breeding of bees and production of medicated honey.

30.12.98 Wednesday

10.15 A.M. : **EVALUATION-17, 18**

11.00 A.M. : **Dr. Twisha Lahiri**
Dept. of Neuroendocrinology, Chittaranjan National Cancer Institute, Calcutta.
Title : Fighting the Big C.

12.30 P.M. : **Dr. P.K. Maiti**
Former Joint Director, Zoological Survey of India, Calcutta.
Title : Biodiversity, its meaning, measurement and maintenance.

2.00 P.M. : **Dr. Anadi Prasad Nandi**
Department of Zoology, University of Burdwan, Golapbag, Burdwan.
Title : Present concept of helminth cuticle.

3.30 P.M. : **Dr. Soumen Maitra**
Department of Zoology, University of Burdwan, Golapbag, Burdwan.

Title : Functional Implications of the Pineal Hormone relation : "A jack of all trades".

31.12.98 Thursday

10.15 A.M. : **EVALUATION-19, 20**

11.00 A.M. : **Dr. Anilava Kaviraj**
Department of Zoology, Kalyani University, Kalyani.
Title : Application of ecological principles in Aqua Farming.

12.30 P.M. : **Prof. Subrata Roy**
Department of Zoology, University of Burdwan, Golapbag, Burdwan.
Title : Role of soil fauna in increasing fertility & productivity of soil.

2.00 P.M . : **Dr. Tushar Kanti Ghosh**
Department of Physiology, Surendranath College, Calcutta.
Title : The ionotropic and metabotropic receptors in the Autononomic junction.

3.30 P.M. : **Dr. Swapan Das**
Department of Zoology, Asutosh College, Calcutta.
Title : The Water Birds of West Bengal : Biology and Status.

01.01.99 Friday

10.30 A.M. : **EVALUATION-21**

11.00 A.M. : **Dr. Chanchal Kumar Manna**
Department of Zoology, Kalyani University
Title : Rodent menace in the gangetic plane, some aspects of the reproductive physiology of the wild Indian house rat (*Rattus rattus*) and the application of some chemosterilants in the control of fertility.

12.30 P.M : **Prof. Arun Kumar Roy**
Department of Animal Physiology, Bose Institute, Calcutta - 700 054.
Title : Concept of Reverse Endocrinology : Its application in animal productivity.

2.00 P.M. : **Prof. Tanmoy Bhattacharya**
Department of Zoology, Vidyasagar University, Mednipur.
Title : Biodiversity, Biocriterion and Environmental Perturbation.

3.30 P.M. : **Sri Pradip Das**
Pearl Bead Centre, 7 Brindabon Mullick Lane, Howrah-711 101.

Title : Workshop - Freshwater pearl culture - theory and practice.

02.01.99 Saturday

10.15 A.M. : **EVALUATION-22**

11.30 A.M. : **Prof. R.K. Poddar**
Former Vice-Chancellor, Calcutta University.

Title : Molecular Phylogeny and Evolutio

12.30 P.M. : **Valedictory Session.**

□

THE 4TH REFRESHER COURSE IN ZOOLOGY
DEPARTMENT OF ZOOLOGY & ACADEMIC STAFF COLLEGE
UNIVERSITY OF CALCUTTA

LIST OF RESOURCE PERSONS

Professor Tapan Kumar Banerjee
Department of Anatomy and Neurosciences
University of Texas, Medical Branch
Galveston, Texas 77555-1069, USA.
Ph: 477-9313

Dr. Amal Kumar Bandhyopadhyay
Head, Department of Helminthology (Retd.)
Calcutta School of Tropical Medicine
Chittaranjan Avenue, Calcutta
Ph : 653-2881

Professor Amar Nath Bhaduri
Indian Institute of Chemical Biology
4 Raja Subodh Mullick Road
Calcutta 700 032

Professor Shelley Bhattacharyya
Professor of Zoology,
Viswa-Bharati, Santiniketan 731 235
West Bengal
Ph : 03463-52838

Professor S.P. Bhattacharyya
Department of Zoology
University of Kalyani, Kalyani 741235
West Bengal
Ph : 829277

Professor Tanmoy Bhattacharyya
Department of Zoology
Vidyasagar University
Midnapore 721102, West Bengal
Ph : 0322-63844

Professor Bireswar Banerjee
Department of Geography (Retd.)
University of Calcutta, Calcutta
Ph : 337-2646

Professor Birendra Nath Bhattacharyya
Department of Zoology (Retd.)
Bangabasi College, Calcutta
Ph : 472-7083

Dr. S.K. Bhattacharyya
Director,
National Institute of Cholera and Enteric Diseases, Calcutta 700 010
Ph: 321-6566

Dr. M.L. Bhowmik
Principal Scientist & Officer-in-Charge,
CIFA (ICAR), Kalyani 741 235, West Bengal
Ph: 560-4068

Professor Amalesh Choudhury
Department of Marine Science (Retd.)
University of Calcutta, Calcutta
Ph: 565-0305

Dr. Goutam Chandra
Department of Zoology
University of Burdwan, Golapbag
Burdwan-713 104, West Bengal

Dr. Samar Chakraborty
Department of Zoology
Univeristy of Burdwan, Golapbag
Burdwan-713104, West Bengal

Dr. Samiran Chakraborty
Department of Zoology
University of Kalyani
Kalyani-741235, West Bengal
Ph: 553-6636

Professor Sanjib Chakraborty
Department of Zoology
University of Kalyani
Kalyani-741235, West Bengal
Ph: 824157

Professor N.B. Chatterjee
Department of Zoology
University of Calcutta
35 Ballygunge Circular Road
Calcutta-700 019
Ph: 549-1647

Dr. R.N. Chatterjee
Department of Zoology
University of Calcutta
35 Ballygunge Circular Road
Calcutta -700 019
Ph: 442-4678

Professor Satipati Chatterjee
Dean, Home Science and
Department of Physiology
University of Calcutta, Calcutta
Ph: 337-2732

Professor Naresh Ch. Datta
Department of Zoology
University of Calcutta
35 Ballygunge Circular Road
Calcutta -700 019
Ph: 577-2050

Dr. Swapan Kumar Das
Head, Department of Zoology
Asutosh College, Calcutta
Ph: 223-5722

Dr. Pradeep Das
Assistant Director
National Institute for Cholera and Enteric
Diseases, P-33, C.I.T. Road, Beliaghata
Calcutta -700 010
Ph: 334-8463

Sri Pradip Das
Pearl Bead Centre
7, Brindabon Mullick Lane
Howrah 711 101
Ph: 746-210

Dr. Asok Kumar Das
Deputy Director
Zoological Survey of India, New Alipore
Calcutta
Ph: 452-9083

Professor Sujit Kumar Dasgupta
Department of Zoology(Retd.)
Presidency College
86/1, College Street
Calcutta 700 073
Ph: 321-8468

Professor T.N. Ghosh
Professor of Protozoology (Retd.)
Calcutta School of Tropical Medicine
Calcutta 700 073
Ph: 556-3148

Professor Madhusudan Ghosal
Department of Zoology
University of Calcutta
Calcutta
Ph: 411-7574

Dr. Subir Ghosh
Member, Wetland Sub-Committee
WWF-India (Eastern Zone)
Calcutta

Dr. Asish Ghosh
Former Director
Zoological Survey of India, Calcutta
Ph : 473-1519

Professor J.J. Ghosh
Professor of Biochemistry (Retd.)
University of Calcutta, Calcutta
Ph : 554-5153

Dr. Tushar Kanti Ghosh
Department of Physiology
Surendra Nath College
Calcutta 700 009
Ph : 350-2864

Professor (Mrs.) Malaya Gupta
Department of Pharmaceutical Technology
Jadavpur University
Calcutta 700 032
Ph : 440-4123

Professor D.N. Jana
Director of Research, Extension & Farms
West Bengal University of Animal & Fishery
Science, 68 Kshudiram Bose Sarani,
Belgachia, Calcutta 700 037
Ph : 556-3396

Professor Durga Prasad Haldar
Department of Zoology, University of Kalyani
Kalyani 741235, Nadia, West Bengal
Ph : 824745

Dr. Anilava Kaviraj
Department of Zoology
University of Kalyani
Kalyani 741235, West Bengal
Ph : 551-0021

Professor Twisha Lahiri
Assistant Director & Head,
Dept. of Neuroendocrinology
Chittaranjan National Cancer Institute
& Research Centre, Calcutta
Ph : 440-6351

Professor Biswa Ranjan Maiti
Department of Zoology
University of Calcutta, Calcutta
241-4719

Dr. Chanchal Kumar Manna
Department of Zoology, University of Kalyani
Kalyani 741235, West Bengal
Ph : 82-7332

Professor Giridhary Majumdar
Department of Zoology
University of Burdwan, Golapbag
Burdwan, West Bengal
Ph : 560-2172

Dr. Prabodh K. Maiti
Former Joint Director
Zoological Survey of India, New Alipore
Calcutta-700 053
Ph : 476-1963

Professor Dipak Ranjan Mandal
Principal, Bidhan Nagar Govt. College
Salt Lake City, Calcutta
Ph : 467-0074

Dr. Kamalesh K. Misra
Department of Zoology
Rishi Bankim Chandra College, Naihati
North 24-Parganas, West Bengal
Ph : 468-4052

Dr. Soumen Kumar Maitra
Department of Zoology
University of Burdwan, Golapbag
Burdwan, West Bengal

Professor Keshab Ch. Mukherjee
Department of Zoology
Asuthosh College (Retd.), Calcutta 700 026
Ph : 442-5381

Professor A.S. Mukherjee
Department of Zoology
University of Calcutta, Calcutta
Ph : 442-5381

Professor S.P. Mukherjee
Department of Statistics
University of Calcutta
Calcutta 700 019
Ph : 334-8497

Mr. K.D. Mukherjee
Apiary and Bee Keeping Cooperative
Baruipur 743 302, South 24 Pgs, West Bengal
Ph : 74-3302

Professor Dilip Kumar Nanda
Department of Zoology
University of Calcutta
Calcutta 700 019
Ph : 478-5387

Professor Amitava Nandy
Professor of Protozoology & Chairman Division
Parasitology, Calcutta School of
Tropical Medicine, Calcutta
Ph : 479-0666

Dr. Anadi Prasad Nandy
Department of Zoology
University of Burdwan, Golapbag
Burdwan, West Bengal
Ph : 0342-68944

Professor S.G. Pal
Department of Zoology
University of Calcutta, Calcutta
Ph : 334-0781

Professor Bikas Chandra Pal
Department of Zoology
Centre for Life Sciences
North Bengal University, West Bengal
Ph : 0353-550113

Dr. Tapan Kumar Pal
Department of Zoology
Vivekananda College
Thakurpukur, Calcutta
Ph : 245-3633

Professor Ramen Kumar Poddar
Former Vice-Chancellor
University of Calcutta
Calcutta
Ph : 337-5646

Professor Aurn Kumar Ray
Department of Animal Physiology
Bose Institue
Calcutta 700 054

Dr. Manas Ranjan Roy
Head, Experimental Hematology Unit
Chittaranjan National Cancer Institute
S.P. Mukherjee Road
Calcutta 700 026
Ph : 462-3685

Professor Subrata Roy
Department of Zoology
University of Burdwan, Golapbag
Burdwan, West Bengal
Ph : 0342-62551

Professor J.N. Rudra
Department of Zoology (Retd.)
Presidency College, Calcutta
Ph: 241-0905

Dr. Gourisankar Sa
Department of Animal Physiology
Bose Institute
Calcutta 700 054

Professor Timir Baran Samanta
Department of Microbiology
Bose Institute, Calcutta
Ph: 337-8953

Dr. Biswatosh Sengupta
Jt. Director, CMDA, Planning Division
Unnayan Bhaban, 4th Floor
Salt Lake, Calcutta 700 091
Ph: 559-0443

Dr. P.K. Sen Sarma
Former Director, Biological Research
Forest Research Institute & Colleges
Dehra Dun 248 006
Ph: 471-2123

Dr. Pranabesh Sanyal, IFS
Department of Environment
Govt. of West Bengal
4 Fairly Place, Calcutta
Ph: 464-1672

Professor Nirmal Chandra Sukul
Department of Zoology
Viswa-Bharati, Santiniketan
Birbhum, West Bengal
Ph: 03463-5297

□

4th REFRESHER COURSE IN ZOOLOGY

LIST OF PARTICIPANTS

1. **Banerjee, Sri Prasun Kr.**
   Department of Zoology
   Sree Chaitanya College
   Prafullanagar, Habra, 24-Pgs.(N)

2. **Basu, Sri Subrata Kr.**
   Department of Zoology
   Nara Sinha Dutt College
   129, Belilious Road, Howrah

3. **Behera, Dr. Bairagi Ch.**
   Department of Zoology
   Kendrapara College, Kendrapara
   Orissa

4. **Chattopadhyay, Smt. Swagata**
   Department of Zoology
   Scottish Church College
   1 & 3, Urquhart Square
   Calcutta-700 006

5. **Dass, Dr. Snigdha**
   Department of Zoology
   Victoria Institution (College Section)
   78/B, A.P.C. Road, Calcutta-700 009

6. **Das, Dr. Lalita** (nee Singhania)
   Department of Zoology
   Maharaja Manindra Chandra College
   Shayam Bazar, Calcutta-700 006

7. **Dutta Gupta, Sri Anup**
   Department of Zoology
   Chandernagore College
   P.O. Chandernagore, Dist. Hooghly

8. **Ghorai, Dr. Narayan**
   Department of Zoology
   Hooghly Mohsin College
   Chinsurah, Hooghly

9. **Ghosh, Sri Madan Mohan**
   Department of Zoology
   Barasat Govt. College
   P.O. Barasat, Dist. North 24-Pgs.

10. **Lahiri, Dr. Papiya**
    Department of Zoology
    Rammohan College
    Rammohan Sarani, Calcutta-700 009

11. **Maity, Sri Narayan Ch.**
    Department of Zoology
    R.K.M.R. College
    Narendrapur, 24-Pgs.(S)

12. **Mishra, Sri Dhananjay**
    Department of Zoology
    Govt. J.M.P. College
    Takhatpur, Bilaspur (M.P.)-495 330

13. **Mukhopadhyay, Sri Shekhar**
    Dept. of Zoology
    Hooghly Mohsin College
    Chinsurah, Hooghly

14. **Mukhopadhyay, Dr. Tushar K.**
    Dept. of Zoology
    Hooghly Mohsin College
    Chinsurah, Hooghly

15. **Nag Chowdhury, Sri Debi Prosad**
    Department of Zoology
    R.K. Mission Sikshanamandira
    Belurmath, Howrah

16. **Naskar, Dr. Chandana**
    Department of Zoology
    Netaji Nagar College for Women
    Regent Estate
    Calcutta-700 092

17. **Raju, D.V. Krishnam**
Department of Zoology,
Ideal Degree College,
Kakuiada - 533 004, Andhra Pradesh

18. **Rej Dr. Swapan Kumar**
Department of Zoology,
Behala College, Parnasree,
Behala, Calcutta - 700 060

19. **Sarkar, Dr. Chinmay Sekhar**
Department of Zoology,
B.K.C. College
111/2, B.T. Road, Calcutta - 700 035

20. **Sadhukhan, Dr. Gobinda Chandra**
Department of Zoology,
Vidyasagar College
39 Sankar Ghosh Lane,
Calcutta - 700 006

21. **Som, Dr. Dipak K.**
Department of Zoology,
Hooghly Mohsin College,
Chinsurah,
Hooghly 712 101

TRANSCRIPTION FACTORS AND STRATEGY IN REGULATING SEX DETERMINATION AND DOSAGE COMPENSATION IN DROSOPHILA AND MAMMALS

A.S. Mukherjee

Department of Zoology, Calcutta University,

Calcutta 700 019

Many nulear proteins have been found to interact with short conserved sequences which are involved in regulating transcription of various genes. They are generally known as ***TRANSCRIPTION FACTORS.*** There are nuclear transcription factors and cytoplasmic transcription factors. I shall primarily restrict myself to neclear transcription factors.

There are two main categories of nuclear transcription factors : (a) Ubiquitous and (b) Tissue-specific. Certain examples of ubiquitous TF's are : CCAAT-binding protein, OTF1, TFIID etc. The examples of tissue-specific TF's are : OTF-2, for immunogobulin gene expression, AP-1, for human collagenase, ER-estrogen receptor, for chicken vitellogenin gene etc. In most cases each of them has specific recognizing sequences, varying from 8 to as long as 1000 base pairs.

These transcription factor proteins can be localized using crude nuclear extracts using foot-printing technique or DNA-finger printing. The binding is detected by simple DNAse protection assay.

Prokaryotic regulatory DNA-binding proteins acting as transcription factor(s) usually recognize palindromic sequences, while in eukaryotes, they may recognize either two-fold symmetrical regions or bind to asymmetrical sequences. A large family of TF's is Zn(+) dependent, e.g. TFIIIA, which have Cysteine and histidine residues interacting with Zinc atoms to form Zinc fingers. In many cases, but not always transcription factors recognizes the TATA box, that is present at the proximal region of the promoter. As a rule, more than one nuclear factor is involved in transcription of eukaryotic genes. For example, at least four different factors are known that control tissue-specific transcription of albumin. So, one can think it reasonable to consider as general rule of thumb, that there should be one to many TF's for regulation of each gene.

At least six factors are known for transcription of light and heavy immunoglobulin chains. In many cases regulation is associated with demethylation and chromatin activation.

Association of demethylation/methylation and chromatin activation/inactivation has been shown in the case of sex determination, dosage compensation in mammalian systems, for neurogenesis gene activation and for anterio-posterior polarity during segmentation. Although, the specific transcription factor or factors are spatially separated from the promoter (and enhancers) the TF action such as demethylation and chromatin activation serve as a signal for the transcriptional

system to be switched on.

In the case of Sex determination in many systems, in general, and in Drosophila, in particular, the gene Sex lethal, which is known as the pivotal gene acting as a binary switch gene for activation of a number of cassettes or cascades of genetic elements downstrem in the hierarchy, is activated by transcription factors associated with nuclear splicing factors e.g. Snf through transcription factors that recognize the promoter as the TFIID. Similarly, the activation of mle gene further downstream in the hierarchy, requires msl1, msl2 and msl3 proteins. In the absence of msl2 as in female *Drosophila*, this activation does not take place. Following activation of mle gene, a set of transcription factors are required for the binding of Mle protein to the X-chromosome in male that leads to chromatin modulation and hyperactivity of the male X. This factor presumbaly comes from a modulator gene located near the Bar gene. The hyperactivation of the male X-chromosome is a manifestation of dosage compensation through male and is casually intimately related to the Sex determination hierarchy. The hierarchic interactions of nuclear factors with enhancer and promoter elements of immunoglobulin genes in mammals, for Ovalbumin genes in chickens, for Sxl gene in Drosophila have been well documented. At least in one system, the transcription complex Pol II is found to be composed of RNA polymerase II and the transcription factor TFIIA, B, D, or E. Cooperative interactions of the proteins with one another and with DNA stabilize the transcriptional complex and increase their affinity for DNA.

Therefore, cell differentiation in eukaryotic systems can be accompanied either by the modification/modulation and/or activation of an appropriate factor or by disappearance of one factor and appearance of another, functionally related factor. One can find a very good example in formation of changing structural patterns from egg or zygote developing through different larval instars to pupa and finally to adult.

Vive' le difference' du differentiation!

Selected References

Lewin, Benjamin (1997). Gene VI. Oxford New York. Oxford University Press.

Timmers, H. Th. M., Meyer, R.E. and Sharp, Ph.A. (1992). Composition of Transcription factor B, — TFIID. P.N.A.S. (USA), 89 : 8140-8144.

Polyanovsky, O.L. and Stepcanko, A.G. (1990). Eukaryotic Transcription factors. Bioessays, 12 : 205-210.

Rastan, S. 1994. X-Chromosome inactivation and the Xist gene. Current Opinion in Genetics and Development. 4 : 292-297.

Mukherjee, A.S. 1998. Dosage comperisation in Drosophila : A pragmatic sequel of hierarchies of segmentation, Neurogenesis and Sex determination. Proc. Indian National Sci. Academy, B64 : 101-124.

□

INTEGRATED COASTAL MANAGEMENT — IN THEORY AND IN PRACTICE WITH SPECIAL REFERENCE TO SOUTH ASIAN REGIONAL SEAS

A.K. Das

Zoological Survey of India,

New Alipore, Calcutta 700 053

The coastal zone is essential to marine life and supports a large part of the living marine resources of the globe, certainly more than the open sea. Its wetlands including mangroves, lagoons, sea grass beds, coral reefs and the shallow bays are the nursery, feeding and breeding grounds for most and many oceanic species. Moreover, this zone is the reservoir of very rich and unique biological diversity. Unfortunately, coastal environments are vulnerable to overexploitation because they include large areas traditionally considered to be 'commons'. That means, they are not owned by any one and everyone is entitled to use them. Recently the global value services obtained from the coastal ecosystems (that is, benefits derived by human population from these ecosystems) has been estimated at a total of US $12 trillion per annum. This amount is equivalent to the estimated combined value of the world's terrestrial and freshwater services (Brown, 1997). The coastal zone is, therefore, extremely important to the coastal countries. Consequently there is concern for its future, particularly regarding the status of its natural resources which provide life support and economic development opportunities to coastal settlers and several other stakeholders.

It is now well established that coastal resources are continuously depleting at a faster rate in many countries. Several driving forces have been recognised for such depletion, such as, (i) high rate of population growth; (ii) poverty exacerbated by dwindling resources, degraded fishery habitats and lack of alternative livelihoods; (iii) large scale, quick profit, commercial enterprises which degrade resources and conflict with interests of the local people; (iv) lack of awareness of the management for resource sustainability among local people and policy makers; (v) lack of understanding of the economic contribution of the coastal resources to the society and (vi) lack of serious government follow up in support and enforcement of conservation programme. Until such forces are minimised or kept under control there is little hope to accomplish environmental conservation or resource sustainability in coastal region.

Integrated coastal management :

If coastal resource systems are to remain productive their management requires a holistic and comprehensive approach. For this purpose it will be required to define a broad management zone extending from the coastal hinterlands and lowlands (the 'dry side') to the coastal waters and

the deep sea (the 'wet side'). Then a multisector management programme must be devised so that all the stakeholders and all government agencies are involved. Integrated Coastal Management (ICM) is one of such approaches to management in order to achieve sustainable use of coastal resources through coherent policy. The ICM is a continuous and dynamic process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystem and resources (GESAMP, 1996). The overall goal of ICM is to improve the quality of life of human communities who depend on coastal resources while maintaining the biological diversity and productivity of the coastal ecosystems.

The traditional ICM process can be conceived as repetition of a cycle of five successive stages, namely, (i) issue identification and assessment; (ii) programme preparation; (iii) formal adoption and funding of programme; (iv) programme implementation and (v) evaluation. At the end of each cycle, the stages are repeated in sequence in the next cycle. The process of developing ICM can be described as a series of steps, namely, awareness, cooperation, coordination and integration. ICM can operate in all levels of governance. Key elements of good practice in ICM include : (i) adoption of a systematic, incremental approach to developing and implementing ICM projects and programmes; (ii) involvement of local communities in the ICM process; (iii) establishment of mechanisms for integration and coordination; (iv) establishment of sustainable financing mechanisms; (v) development of ICM capacity at all levels; (vi) monitoring of the achievements of ICM projects and programmes and (vii) integrating environmental, economic and social information from the very beginning of the ICM process. All these aspects will be elaborated with case studies during the deliberation of the topics.

ICM in the South Asian Seas Region :

India, Pakistan, Bangladesh, Sri Lanka, Maldives and the British Indian Ocean Territory (the Chagos Archipelago) are the countries which are included in the South Asian regional seas. Not only that coastlines of all these countries are bathed by the Indian Ocean but also that all of them share the common problems of increasing population pressure and the resultant increasing demands on the coastal zone at an alarming level. The entire population of Maldives can be described as coastal dwelling whereas 80 per cent, 50 per cent and 25 per cent of the population of Bangladesh, Sri Lanka and India respectively are living along the coast and exploiting the coastal and marine resources nonsustainebly for their livelihood or for commercial purpose. Moreover, as case histories of several South Asian countries reveal, coral and sand mining, intensive shrimp farming, reef-related fisheries, pollution in the coastal zone, river basin mangement and coastal tourism are also posing threats to this ecosystem.

To meet these challenges, at least in part, ICM practice is currently being developed throughout the region and is given a high priority. Despite the various nature of case histories available in

different parts of this region there are five common weaknesses as given below :

1. A lack of enforcement of existing legislation.
2. A need to evolve greater community participation in management of resources.
3. A lack of relevant scientific information needed to underpin sustainable management, and a requirement to improve dissemination of what is already known throughout the region.
4. A complex array of institutional agencies involved in the management of a single resource with often an inadequate coordination of environmental policy by the nominated lead agency.
5. Few truely integrated coastal managment programmes, apart from the one or two exceptions in the region.

ICM projects are already underway in several countries including India. It is expectted that above mentioned weaknesses will be overcome. There is an example of good ICM practice in Sri Lanka. There are also several encouraging management practices in other South Asian region, such as, mangrove restoration in Indus delta, joint forest management in West Bengal, marine park management in Andamans, environmental awareness in the tourism industry of Maldives, etc. The future success of ICM in the South Asian seas region rests on how the good lessons from all these could be utilised involving local community and using the skills of the personnel of the region.

Selected References

Brown, B.E. (1997). "Integrated Coastal Management : South Asia". Department of Marine Sciences and Coastal Management, University of New Castle, New Castle upon Tyne, United Kingdom.

Chua, T.E. and White, A.T. (1988). Policy recommendations for Coastal Area Management in the ASEAN Region. Contrib. No. 544, ICLARM, Manila : 1-10.

GESAMP. (1996). The contributions of science to Integrated Coastal Management. Rep. Stud. GESAMP (61) : 1-66.

□

EVOLUTIONARY ORIGINS OF GENE DOSAGE COMPENSATION : AN OVERVIEW

R.N. Chatterjee

Department of Zoology, University of Calcutta,

35, B.C. Road, Calcutta - 700 019

One of the consequences of sex chromosome heteromorphism is that there are differences in the amount of quality of the genetic material in the two sexes. The heterogametic sex (XX and ZW in female and XY and ZZ in male) has a single dose of some genes which are present in double dose in homogametic sex. In different animal groups, where precise differentiation of the sex chromosomes in the two sexes have been established, the need for dosage compensation has been followed as an obligatory consequence depending on the functional significance of the genes in the inactivated or lost segment of the Y chromosome. Thus, dosage compensation of X linked genes can be considered as an evolutionary strategy required to equalize gene expression between individuals possessing different numbers of sex chromosomes for sex determination. The phenomenon of equalization of the X linked gene products therefore, acts as a factor against the selection preference for a particular sex and restores the balance for the haplo-X in the sex against the diplo-X of the other. Therefore, it is reasonable to believe that strong selection forces favour it. Exceptions are however, evident in systems where females are heterogametic, for example, Ophidians, avians and Lepidopterans.

To understand the molecular solution of such compensatory mechanisms, most of the investigators have so far been restricted mainly to the three animal groups — the nematods, *Drosophila* and mammals. These animal groups have the XY/XO type male heterogamety though the mode of sex differentiation is some what different in the three systems (Bull, 1983). So far, four different ways of achieving dosage compensation have been recorded, such as (a) enhancing the transcriptional output of the single X chromosome in males, e.g. *Drosophila*, (b) reduction in the level of expression from the two X chromosomes in XX animals e.g. *C. elegans*, (c) eliminating unwanted chromosomes in somatic cells, e.g. *Sciara* and (d) silencing of one of the two X chromosomes in female e.g. Mammals. As dosage compensation mechanisms found so far in insects, nematodes and mammals do not share a common ancestry it is generally believed that dosage compensation may have evolved apparently independently at least three evolutionary lineages (Chatterjee, 1998). Yet, biochemical and genetical data support the hypothesis that fundamental programming for dosage compensation restores the genetic balance. The concept of genic balance means that the product level of sex linked genes bear the same relation to the average level of autosomal gene products in both sexes. Clearly, genes responsible for sex

determination or sexual dimorphism are excluded from this requirement. However, a large number (nearly 500 to 1000 genes) of other X linked genes that code for 'house keeping' and specialized functions, respond to genetic programming to compensate for two fold differences in the number between two sexes. Different organisms have evolved different mechanisms to compensate for the dosage differences of X chromosomes in the two sexes.

From an evolutionary stand point, it is an obvious question how genetic programming for dosage compensation is related in different organisms. Various lines of evidence (Charlesworth, 1978, 1991, 1996) clearly suggest that the mechanisms of sex determination systems in different groups of animals storngly suggest that although a variety of mechanisms are used for determination of sex in different species, a relatively simple evolutionary force have been involved in it. However, sex determination often involves the differentiation of the structure of the sex chromosomes. During evolution, structural changes in the Y chromosome is associated with stepwise reduction of the Y chromosome activity. The evolution of genetic inertness of the Y chromosome cause severe imbalance in gene dosage between sexes — a functional aneuploidy. The deleterious effects associated with X chromosome aneuploidy between two sexes produce a strong selection pressure to develop a regulatory mechanism for compensation. In consequence, compensatory mechanisms are adapted to restore the balance between autosomal and X chromosomal gene products. A comparative study of the mechanism of dosage compensation systems in different group of animals further suggests that it is the product of a complex evolutionary process. A scenario can be developed to explain the compensation system in different animals without greatly involving molecular mechanisms of the system. To date, the data suggest that a single principle of dosage compensation system is operative in all taxa, but there is no resemblance in terms of molecular biology. As natural selection is opportunistic and always utilise common mechanism in different taxa, it is considered that somatic dosage compensation and X chromosome inactivation in germ line of the heterogametic sex may have evolved as independent solutions of degeneration and/or absence of a chromosome (i.e. in case of X0 male) in different animals. This may lead us to suggest that different systems of dosage compensation found today may be the refinement of different biochemical processes of X chromosome regulation in the whole animal kingdom. Although the imminent understanding of the mechanism of dosage compensation in different animal groups has yielded some insights into the evolution of dosage compensation to make further progress more evidence is needed on comparative genetics and molecular biology of sex determination and dosage compensation systems, particularly for the sex chromosomes that have originated recently.

Selected References

Bull, J.J. (1983). Evolution of sex determining mechanisms. Benjamin / Cummings, California.

Charlesworth, B. (1978). Model for evolution of Y chromosomes and dosage compensation. Proc.

Natl. Sci. Acad. (USA), **75** : 5618-5622.

Charlesworth, B. (1991). The evolution of sex chromosomes. Science, **251** : 1030-1033.

Charlesworth, B. (1996). The evolution of chromosomal sex determination and dosage compensation. Current Biol., **6** : 149-162.

Chatterjee, R.N. (1998). Mechanisms and evolutionary origins of gene dosage compensation. In 'Genome Analysis in Eukaryotes : Developmental and Evolutionary aspects' (Eds. R.N. Chatterjee and L. Sanchez) pp. 167-214, Narosa-Springer-Verlag, Delhi, London, Berlin.

□

SEWAGE-FED AQUACULTURE AND ASSOCIATED PROBLEMS

M.L. Bhowmik

Regional Research Centre, Central Institute of Freshwater Aquaculture (I.C.A.R.)
Kalyani, Nadia, West Bengal

The production of fish in ponds fertilized with human wastes in an age old practice in many parts of Asia, where macrophytes are also cultivated in this way and was also known in medieval Europe. The use of wastewater in aquaculture was developed in Germany at the end of 19th Century and independently and indigenously in Calcutta in 1930, which now has the largest wastewater aquaculture system in the world. Because of the high BOD level of wastewater and the resulting deoxygenation of the water during night fish usually can not be cultured directly in the wastewater itself. Measures must be taken to reduce the BOD. This usually is brought about by one of the following methods :

a. Treating the wastewater to such a degree that it does not create any hazards to fish;
b. Diluting the wastewater before its introduction into the pond. This is the method adopted by the classical example of Munich's (Germany) wastewater fish ponds;
c. Diluting the wastewater in the pond by the water contained in the pond. The pond water may be freshwater or aged and stabilized wastewater. The best example for this system is that of Calcutta (Bose, 1944; Basu, 1949 and Nair, 1944).

The capacity of aquaculture ponds to purify wastewater is greater, than the conventional treatment methods (Kisskalt and Ilzhofar, 1937). According to them on the basis of studies at

Munich's wastewater fish farm the reduction of total bacterial count by the trickling filter method was about 89% and by the activated sludge method about 90%, the reduction of bacterial count in fish ponds receiving the water reached 99.6%. Bhowmik *et al.* (1997) also reported same trend of reduction. Schroeder (1974,1975) and Wolny (1966) demonstrated that presence of fish in wastewater ponds improves the quality of treatment in the light of reduction in bacterial load and BOD level. Oswald (1972) reported that increasing D.O. and pH in an aquatic system, increases the rate of disinfection from coliform.

The high concentration of nutrients, especially Phosphates and Nitrogen, in wastewater affect the ecology of natural water bodies into which the water is discharged. The fates of these two nutrients in fish ponds has been studied from the view point of beneficial fertilization of the water for increasing the ponds productivity. Most of the Phosphorus and Nitrogen added to the water is lost to the mud or to the atmosphere (Matida, 1956; Hepher, 1958). For Phosphorus this is due to an equillibrium between its soluble state and insoluble phosphate in the mud (Hayes *et al.*, 1952; Olsen, 1958, 1964; Hepher, 1966) in which the amount of the insoluble Phosphate is far greater than the soluble phase. The addition of soluble Phosphate to the water affects the equillibrium but it tends to be restored quickly by precipitation as Iron Phosphate and Manganese Phosphate or adsorption of their hydrates (Einsele, 1938,1941) in water rich in these metal and low in pH. The precipitation of Calcium Phosphate seems to be much more common as it occurs at a higher pH (Matida, 1956; Hepher, 1958 and Golterman, 1967). The removal of phosphate in this process depends on the concentration of calcium, alkalinity (Barrett, 1953) and the pH of the water.

Nitrogen added in the water is lost partly by denitrification process when partial anaerobic conditions exist near bottom; however most of the Nitrogen loss is due to transition of NH_4 to gaseous NH_3 to the atmosphere. The equillibrium between NH_3 and NH_4 depends mainly on pH and C.E.C. of mud soil. At pH 9.5 and at a temperature of 25°C, over 60% of the total ammonium compounds will be in the gaseous state. Increasing temperature or pH further increase the shift towards the gaseous state. Stocking of fish in waste treatment ponds results in higher pH probably, because of the grazing of fish on the plankton maintans the ponds in the better ecological balance. Oxygen production and respiration are more in balance and excess of CO_2, which depress pH, do not occur.

Fish have been shown to accumulate bacteria and viruses in several body tissues including muscles and organs such as kidney, prone-phoros and liver (Buras *et al.*, 1985). The degree of accumulation is dependent on the concentration fo the bacterium or virus present in the aquaculture pond, and is a function of the type of micro-organisms. Buras *et al.* (1985) further reported that inspite of the presence of coliforms and faecal coliforms in high numbers in the pond water could not be recovered from muscles of fishes cultured in the system. Microbial flora changes from a predominantly faecal character to one approaching that of an enriched freshwater after biological treatment.

There are three distinct health problems associated with the reuse of sewage in ponds (Feachem *et al.*, 1983) :

1. Passive transfer of pathogens by contaminated fish.
2. Transmission of helminths in which fish are intermediate hosts.
3. Transmission of helminths in which other pond fauna are intermediate hosts.

The first is cause for worldwide concern. The second and third occur only in areas with particular eating habits or where the helminths are endemic or both.

It is generally accepted that the intestinal bacteria of warm-blooded animals (humans and livestook) do not cause disease in fish and are absent from fish caught in unpolluted water (Guelin, 1962; Buras, 1977; Feachem *et al.*, 1983). There is no permanent coliform or streptococcai bacterial flora in the intestinal tract of fish (Feldreich and Clark, 1966). Salmonellae have never been found to cause disease in aquatic animals (Buttiaus, 1962).

However, fish growing in an environment contaminated with excreted pathogens may acquire substantial numbers of pathogens on their body surfaces and in their intestines. Enteric bacteria such as faecal coliforms, faecal streptococci and salmonellae may be readily isolated from fish grown in water contaminated with excreted pathogens (Feachem *et al.*, 1983). The bacterial flora of a fish reflects the bacteriological quality of the water from which it is taken (Guelin, 1962; Geldreich and Clark, 1966; Buras *et al.*, 1987) and may be passive carriers of human pathogens in water polluted by sewage (Brown and Dorn, 1977). There appears to be a concentration effect because densities of enteric bacteria in fish intestines tend to be higher than in polluted waters (Feachem *et al.*, 1983). There are very few data on the passive transfer of excreted pathogens causing diseases in humans. Public health problems concerning fish have usually been traced to contamination following harvest during handling, transportation, and storage (Brown and Dorn, 1977; Feachem *et al.*, 1983; Scarpino, 1983). Most salmonella contamination of fish occurs when handling, transporting or processing operations are carried out under inadequate sanitary conditions (Buttiaus, 1962). However, it is possible for pathogenic bacteria from excreta-fed ponds to be carried passively by harvested fish and then to infect those who handle, prepare or eat the contaminated fish (Feachem *et al.*, 1983).

There is little risk from insanitary disease in eating well-cooked fish because thorough cooking destroys pathogens; consumption of raw or partially cooked fish may lead to infection (Feachem *et al.*, 1983). However, the risk to persons who handle or prepare fish remains, irrespective of local eating habits (Feachem *et al.*, 1983).

The current wisdom on excreta treatment processes is that temperature and times are two most important parameters in pathogen attenuation (Feachem *et al.*, 1983). To obtain an almost pathogen free product, treatment needs to incorporate a long detention time (ponds, protracted digestion, drying) and heat, wastewater fish ponds are the most economically efficient method of excreta treatment where land is available at relatively low cost (Mara, 1976; Arthur, 1983), and

their principal advantage in warm climates is the ability to achieve significantly lower survival rates of excreted pathogens than other methods of treatment. Pond systems can be designed to eliminate all excreted pathogens (Faechem *et al.*, 1983).

Improved methods of sewage treatment through aquaculture, assessment of the quality of the aquaculture products together with changing attitudes towards the needs and benefits of waste recycling and the associated economic and energy savings thereby will create an environment in which combined aquaculture waste treatment systems will prove universally acceptable and desireable.

Selected References

Arthur, J.P. (1983). Notes on the design and operation of waste stabilization ponds in warm climates of developing countries. World Bank Technical paper No.7, The World Bank, Washington, D.C. 106 pp.

Basu, S.P. (1949). Research report ecology of sewage irrigated fisheries in the Bidyadhari spill area, with particular reference to the bionomics of carp cultured therein. Ann. Rep. Nat. Inst. Sci. India.

Barrett, P.H. (1953). Relationship between alkalinity and absorption and regeneration of added phosphorus in fertilized trout lakes. Trans. Amer. Fish. Soc., **82** : 78-90.

Bhowmik, M.L., A. Chattopadhyay, N.K. Manna and B.K. Pandey (1997). Biological treatment of sewage with reference to microbial load, nutrients and fish growth. In : National Seminar on Fish Biology held at Visva-Bharati University, Santiniketan, India. 17-19 March 1997. Abstract, FEN-11.

Bose, P.C. (1944). Calcutta sewage and fish culture. Proc. Natl. Inst. Sci. India. **10** : 443-454.

Brown, L.D. and C.R. Dorn (1977). Fish, Shellfish, and human health. J. Food Protection, **40** : 712-717.

Buras, N. (1977). The influence of the bacteriological water quality on the concentration of bacteria in fish. Proc. Eighth Scientific Conference Israeli Ecological Society, pp. 162-169.

Buras, N., L. Duck and S. Niv (1985). Reactions of fish to micro-organisms in wastewater. Appl. Environ. Microbiol., **50** : 989-995.

Buras, N., L. Duck, S. Niv, B. Hepher and E. Sandbank (1987). Microbiological aspects of fish grown in treated wastewater. Wat. Res., **21** : 1-10.

Buttiaux, R. (1992). *Salmonella* problems in the sea. In : G. Borgstrom (ed), Fish as Food, Vol. 2, pp. 503-519, Academic Press, New York.

Einsele, W. (1938). Uber chemische and Koloid chemische vorgange in Eisen-System Under limnochemischen and limnogeologischen Gesichtspunkten. Arch. Hydrobiol., **33** : 365-387.

Einsele, W. (1941). Die Umsetzung von zugefuhrtem anorganischen phosphat in entrophen see and ihre Ruckwirkung auf seine Gesamthaushalt. Zeit. Fisch., **39**(3) : 407-488.

Feachem, R.G., D.J. Bradley, H. Garelick and D.D. Mara (1983). Sanitation and Disease : Health Aspects of Excreta and Wastewater Management. John Wiley & Sons. Chichester.

Geldrich, E.E. and N.A. Clarke (1966). Bacterial pollution indicators in the intestinal tract of freshwater fish. Applied Microbiol., **14** : 429-437.

Golterman, H.L. (1967). Influence of the mud on the chemistry of the water in relation to productivity. In : H.L. Golterman and R.S. Clymo (Eds.) chemical environment in aquatic habitat. N.V. Noord-Hollandsche Uitgevers Maatscha ppij, Amsterdam : 297-313.

Guelin, A. (1962). Polluted waters and the contamination of fish. In : G. Borqstrom (Ed.) Fish as food vol. 2. Nutrition, Sanitation and Utilization. Academic Press. N.Y. and London : 481-502.

Hayes, F.R., J.A. McCarter, M.L. Cameron and D.A. Livingstone (1952). On the kinetics of phosphorus exchange in lakes. J. Ecol., **40**(1) : 202-216.

Hepher, B. (1958). On the dynamics of phosphorus added to fish ponds in Israel. Limnol. Oceanogr., **33** : 361-387.

Hepher, B. (1966). Some aspects of the phosphorus cycle in fish ponds. Verh. Int. ver. Limnol., **16**(3) : 1293-1297.

Kisskalt, K. and H. Ilzhofer (1937). Die Reinigung von Abwasser in Fischteichen. Arch. Hyg., Berlin, **118** : 1-66.

Mann, K. (1972). Macrophyte production and detritus food chains in coastal waters; detritus and its role in aquatic ecosystems, P. 370. Memorie Dell Instituto Italiano Di Idrobiologia 29 : 1 BP-UNESCO Symposium.

Mara, D.D. (1976). Sewage Treatment in Hot climates. John Wiley & Sons, Chichester. 168 pp.

Matida, Y. (1956). Study of farm pond fish culture 3. Fates of fertilized elements and the relationship between the efficiency of fertilizer and biochemical environment in the pond. Bul. Freshwat. Fish. Res. Lab. Tokyo, 4(1) : 33-40.

Nair Krishnan, K. (1944). Calcutta sewage irrigation fisheries. Proc. Nat. Inst. Sci. India, **10** : 495.

Olsen, S. (1958). Phosphate obsorption and isotopic exchange in lake muds. Experiments with P-32. Preliminary report. Verh. Int. ver. Limnol., **13** : 915-922.

Olsen, S. (1964). Phosphate equilibrium between reduced sediments and water. Laboratory experiments with radio-active phosphorus. Verh. Int. ver. Limnol., **15** : 333-341.

Oswald, W. (1972). Complete waste treatment in ponds. 6th International water pollution research. N.V. Pergamon Press 8/3/6/1.

Pearson, H.W. and A. Konig (1986). The biology of waste stabilization pond systems. Regional Research Seminar on waste stabilization ponds, CEPIS, Lima, March 1986. 17 pp.

Scarpino, P.V. (1983). Selection of practical indicator systems for monitoring the virological quality of potable water, wastewater, solid waste, shellfish, fish and crops. Water Sci. Tech., **15** : 17-32.

Schroeder, G. (1974). Use of fluid cowshed manure in fish ponds. Bamidgeh, **26** : 84-96.

Schroeder, G.L. (1975). Some effects of stocking fish in waste treatment ponds. WAter REs., **9** : 591-593.

Shewan, J.M. (1962). Food poisoning caused by fish and fishery products. In : G. Borgstrom (Ed.) Fish as food Vol.2 Nutrition, Sanitation and Utilization. Academic Press, N.Y. and London : 443-466.

Wolny, P. (1966). The use of purified town sewage for fish rearing. Roczniki Nauk Rolniczych Seria B. Zootechnicza, Warsaw, **18** B(2) : 231-249.

□

EARLY HISTORY OF VERTEBRA FORMATION AND STRUCTURE OF THE SPINAL COLUMN IN BIRDS

B.N. Bhattacharyya

Department of Zoology,

Bangabasi College, Calcutta

The early history of verterbra formation may be traced back to the development of the neural tube, the notochord and the mesodermal somites in the embryo. The most significant phenomenon is the differentiation of the mesodern that lays the foundation of vertebra formation. The mesoderm can be conveniently divided into three distinct parts : (i) the dorsal or segmental mesoderm represented by the mesodermal somites, the unsegmented (ii) intermediate mesoderm which connects the dorsal with the lateral mesoderm, and though unsegmented, it gives rise to segmented nephrotomes and the (iii) unsegmented lateral mesoderm composed of an outer somatic and an inner splanchnic layer, enclosing a space, the coelom in between the two.

The first pair of mesodermal somites differentiate at 21 hrs. of incubation of the chick embryo on either side of the neural tube and the notochord. Thus, the paired somites are added, one pair every hour, behind the first pair of somites. The paired somites subsequently give rise to thicker myotomes inwardly, destined to form the voluntary musculature of the adult, and outwardly, give rise to paired, thinner dermatomes destined to form connective tissue and most of the deeper layer of the skin.

The sclerotomes arise from the loose mesenchyme cells which are budded off serially from the inner region of the myotomes. The paired sclerotome units then migrate towards the notochord around which they form the notochordal sheath. Each sclerotome block having a less dense cranial part and a dense caudal part splits into two half-selerotomes, and in the majority of vertebrates, the dense caudal part of each sclerotome unites with the less dense cranial part of the succeeding sclerotome. As a result, the myotome block which previously coincided with the scleortome block of a particular somite now alternates between the two somites. This imparts an adaptational advantage in the lateral flexion of the body of a vertebrate. The sclerotomal mesenchymal cells now aggregate dorsally and ventrally in each half of the half-sclerotome on either side of the notochord and the neural tube and the two dorsal and two ventral components thus formed are known as basidorsal, interdorsal, basiventral and interventral components which later chondrify, forming distinct cartilages called arcualia around the notochord. The mesenchyme cells which transform into chondrioblast cells forming cartilagenous arcualia may form the centrum around the notochord either through acrocentrous or through chondrocentrous method. However, the formation of centrum does not depend on the arcualia alone. Loose mesenchyme cells may also condense to form a cylinder of perichordal mesenchyme around the notochord. This may eventually produce a bony perichordal centrum, as found in teleostean fishes and amphibians. In amniotes, the perichordal mesenchyme may condense to form two embryonic cartilages, a hypocentrum and a pleurocentrum on either side, and these with arcualia contribute to the formation of a bony vertebra in all vertebrates, except in the cyclostomes and the elasmobranch fishes.

The vertebral column functions as the main axial skeletal framework of the body. The structures of the vertebral column and its associated ribs and sternum are widely variable in different groups of vertebrates. Among the amniotes, the carinate birds have probably reached the climax of adaptational changes which have been reflected in all their organ-systems, including the skeleto-muscular system. The shortening and fusion of visceral part of the spinal column, heterocoelous cervical vertebrae in general for greater mobility of the neck, strong hypapophyses from the posterior cervical and anterior thoracic vertebrae, a large keeled sternum acting as a plate-girder and as origin-sites for the great muscles of flight, the fully ossified ribs with uncinate processes, the hollow-girder system of pneumatized bones some of which have internal strutting to bear the stresses, the nearly parabolic and ridged sacral girder for perfect distribution of weight and the upturned pygostyle are some of the remarkable modifications and achievements in flying birds.

However, there are certain glaring exceptions, such as the Penguins, Gulls, Plovers and Parrots possess opisthocoelous thoracic vertebrae, the *Archaeopteryx* and *Ichthyornis* possessed amphicoelous vertebrae, the *Strigops* (Psittaciformes) lacked a keel, the Screamers (Anseriformes) and Megapodids lack uncinate processes, and the ratites in general possess a flat sternum without keel or with a slight crest.

The joints and ligaments play a significant role in the articulations of the vertebral column and its associated parts. Although synovial joints with intra-articular menisci are very common in the cervical and anterior thoracic vertebrae, in the caudal thoracic region and in the synsacrum, these joints become ankylosed forming synostosis and those between free caudal vertebrae are symphyses or synovial joints. The vertebral ligaments protect the vertebral articulations by restricting their movements.

An overview of the embryology of vertebra formation in general and morphology of the spinal column in birds in particular is presented in the text in brief through description and illustration.

Selected References

Baumel, J.J., King, A.S., Breazile, J.E., Evans, H.E. and Vanden Berge, J.C. (eds.) (1993). Handbook of Avian Anatomy : Nomina Anatomica Avium, Second Edition, Publ. No. 23, Nuttal Orn. Club, Harvard Univ., Cambridge.

Baumel, J.J. (1985). Suspensory ligaments of nerves : an adaptation for protection of the avian spinal cord. Zbl. Vet. Med. C. Anat. Histol. Embryol., **14** : 1-5.

Buhler, P. (1981). Functional anatomy of the avian jaw apparatus. In : 'Form and Function in Birds' (A.S. King and J. McLelland. eds.), Vol. 2 : 439-468. Academic Press, N.Y., Lond.

Huettner, A.F. (1949). Fundamentals of comparative embryology of the vertebrates, Pp : 1-309 + I-XV. The Macmillan Co., N.Y.

Parker, T.J. and Haswell, W.A. (1940). 6th Ed., Vol.II, A Text Book of Zoology. Pp : 1-758 + I-XXIII, Macmillan & Co., Lond.

Weichert, C.K. and Presch, W. (1977). (TMH Ed.). Elements of Chordate Anatomy. Pp : 1-626 + I-VIII. McGraw Hill Publ. Co., New Delhi.

Young, J.Z. (1981). The life of Vertebrates, 3rd Ed., ELBS (1988), Pp : 1-645 + I-XV., Oxford Univ. Press.

□

LESSONS FROM THE GOLGI DISCOVERY

S.G. Pal

Department of Zoology, Calcutta University,

35, Ballygunge Circular Road, Calcutta 700019

In basic sciences there are many cases of serendipity. The Italian biologist Camillo Golgi described a dark basket-like network around the nucleus of Purkinje Cell following staining with metals (1898). This he labelled as "apparto reticolare interno" or "internal reticular apparatus". This discovery spawned a cascade of controversies, generated few newer data on membranous vacuolar transport and traffic including glycosylation. In fact, investigations on Golgi complex during the last 100 years have enormously diversified and fresh results are hardly free from controversies. Some of the unique discoveries relating to the Golgi complex will be mentioned to establish its bonafide organellar nature and important functions within secretory cells, dividing cells, etc. The introduction of DNA technology in the characterisation of Golgi membrane proteins and their signal capabilities has led to fresh debates. The following is a brief description of the Golgi complex in both animal and plant cells.

The original debate centred on the deep black metal reaction (la reazione nera) introduced by Golgi when he was in Pavia. For a long time this was considered as an "artifact" because the organelle could not otherwise be observed in the living cells. In 1954 Dalton and Felix first demonstrated the original transmission electron microscopical picture of the Golgi apparatus from the epididymis epithelial cells, where the organelle maintains a polarised position. Essentially it is composed of several flattened membranous sacs, the termini of which are occupied by small vesiles and there occur large vacuoles on the concavity of the organelle. The number, distribution of this organelle are variable from cell to cell. In *chara* the number is more than 25000 and in salivary gland cell there are hundreds of these.

In recent years the association of Golgi complex with spectrin has been demonstrated. Few other motor elements are found close to the Golgi complex. Structurally each Golgi complex is divided into four distinctive compartments, each with specific marker enzymes of proteins — (a) Cis (or Cis Golgi Network CGN), (b) medial, (c) trans and (d) trans Golgi network (TGN). These boundaries are not always sharp and consequently much overlapping occurs. Along with this segmentation of the Golgi complex, the GERL concept of Novikoff (1971) established the functional connexion with both endoplasmic reticulum and lysosomes. Therefore, the traffic between the protein secretory vesicles from the rER through the intermediacy fo the Golgi apparatus to the lysosomes and others, has been documented by autoradiography and electron microscopy. The earlier works of Leblond (1966) and Northcote (1966) and their coworkers respectively in mucus

cells of rat intestine and in root cap cells have provided evidence in support of the fact that most proteins are modified by the addition of sugars, lipids or other groups in the Golgi complex. Following these basic studies the concept of "signal" and its retrieval during the vesicular traffic through the Golgi complex has been elaborated in depths. It is established that newly synthesized proteins are sorted in the TGN wherefrom these reach their subcellular destinations, lysosomes, multivesicular bodies, exocytotic vesicles, etc. through a selective procedure. Some of the recent debates on vesicle formation traffic and membrane recycling will also be touched in the deliberation.

Finally, from the position of an "artifact", many of the details on the structures and functions of the Golgi complex have been worked out. But, however, we need to keep our fingers crossed for newer conceptual challenges of the Golgi complex (Berger and Roth, 1997).

Selected References

Golgi, C. (1898). Arch. Ital. Biol., **30** : 60.
Dalton, A.J. and Felix, M.D. (1954). Am. J. Anat., **94** : 171.
Novikoff, P.M. *et al.* (1971). J. Cell Biol., **50**: 859.
Neutra, M. and Leblond, C.P. (1966). J. Cell Biol., **30** : 137.
Pickett-Heaps, J.D. and Northcote, D.H. (1966). J. Exp. Bot., **17** : 20.
Berger, E.G. and Roth, J. (1997). The Golgi Apparatus. Birkhäusher.

□

SIGNAL TRANSDUCTION MECHANISMS IN THE STRESS RESPONSE OF HEPATOCYTES

Shelley Bhattacharya
Environmental Toxicology Laboratory
Department of Zoology, Viswa Bharati University,
Santiniketan 731235

Adaptation of animals to stress is a unique property of life which allows the survival of the species. The classical stress response as proposed by Selye (1946) took account of the hormonal facets of physiological homeostasis as the sites of manifestation of stress response. The general

adaptation syndrome or GAS deals mainly with the release of stress hormones and their fallout action. GAS has its cue from the pituitary-adrenal system to release profuse amounts of corticosteroids and stimuli which initiate this action are emotional, physiological, or environmental in origin. However, no attention is paid to the liver, the main organ in which metabolism takes place, which could be considered a significant target of a variety of stressful stimuli. With the increase in industrialization and adoption of advanced methods of agriculture, the stress response of hepatocytes has attracted some attention because every man-made chemical has been proven to enter the animal body and cause serious damage in the liver. Many of the exogenous chemicals entering the animal body can be categorized under the group of hepatotoxic agents, which impose their primary action on hepatocytes. Despite the wide variety of compounds encountered by the living systems which are harmful, the organism does survive the xenobiotic onslaught. Obviously, the liver has certain inherent mechanisms to counteract stress which provide resiliene to the individual for survival.

The response to stress by an individual is a reflection of the response syndrome manifested by the cell. Among all cell types hepatocytes are unique because they belong to the category of a tissue which keeps a constant metabolic vigil. Chemical-indued liver damage has long been recognized as a major toxicological problem. Historically, in the 1800s scientists tried to decipher the mechanisms involved in the deposition of lipids on exposure to yellow phosphorus, whereas in the first 40 years of this century more concern was focussed on liver injury caused by arsphenamine, CCl_4, and chloroform and hepatic cirrhosis by excess alcohol consumption (Hayes, 1990). The toxic response of the liver cannot be categorized as a single entity; rather it is a plethora of responses. The response is directed not only by the chemical but also by its dose and duration of exposure. Different biochemical changes may lead to the same end result and there can be no single mechanism governing the appearance of the degenerative changes.

The liver is highly vulnerable to xenobiotic action because of its proximity to the portal circulation and its enormous capacity to biotransform xenobiotics and regulate the excretion of the solubilized xenobiotics. Thus, both biochemical and functional manifestations are important in the signal transduction mechanisms of the hepatocytes. Cellular responses to a variety of stresses have been illustrated by an increase in the glucose uptake (Garry *et al.*, 1986; Gray *et al.*, 1983; Landini, 1984; Warren *et al.*, 1986) and *de novo* synthesis of proteins such as the heat shock proteins (Craig, 1985; Lindqvist, 1986). *In vivo* response is recorded in the liver in which various proteins are induced, such as C-reactive proteins (Agrawal and Bhattacharya, 1989, 1990a; Ghosh and Bhattacharya, 1993), metallothioneins (Dalal and Bhattacharya, 1991; Bose *et al.*, 1994), and metallothionein-like proteins (Agrawal and Bhattacharya, 1990b), or in the detoxication pathways which, also considerably induce the respective enzyme synthesis, such as glutathione-S-transferase. Rather idiosyncratic responses of hepatocytes are on record with interactions institute between dietary xenobiotics, drugs, and biologically active endogenous compounds (endobiotics).

It was found that the common food additives are potent inhibitors of human liver 17α-ethinyloestradiol and dopamine sulfotransferases (Bamforth *et al.*, 1993). Obviously, the signals of intoxication are triggered first, followed by detoxication signals. There is only one report on the signal transduction mechanism adopted by a xenobiotic which does not follow any of the pathways generally known for hormones and neurotransmitters (Bhattacharya *et al.*, 1997).

Selected References

Agrawal, A. and Bhattacharya, Shelley (1989). Appearance of C-reactive protein (CRP) in the serum and liver cytosol in Cd-treated rats. *Ind. J. Exp. Biol.*, **27** : 1024-1027.

Agrawal, A. and Bhattacharya, Shelley (1990a). Possible role of C-reactive protein in detoxication of mercury. *Ind. J. Exp. Biol.*, **28** : 638-641.

Agrawal, A. and Bhattacharya, Shelley (1990b). Purification of a metallothionein-like protein (MLP) from the serum of Hg-treated rats using phosphorylcholne-Sepharose affinity column. *Ind. J. Exp. Biol.*, **28** : 648-652.

Bamforth, K.J., Jones, A.L., Roberts, R.C. and Coughtrie, M.W. (1993). Common food additives are potent inhibitors of human liver alpha-ethinyloestradiol and dopamine sulfotransferases. *Biochem. Pharmacol.*, **46**: 1713--1720.

Bhattacharya, Shelley, Bose, S. *et al.* (1997). Specific binding of inorganic mercury to Na^+-K^+-ATPase in rat liver plasma membrane and signal transduction. *BioMetals*, **10** : 157-162.

Bose, S., Mukhopadhyay, B., Chaudhury, S. and Bhattacharya, Shelley (1994). Correlation of metal distribution, reduced glutathione and metallothionein in liver and kidney of rat. *Ind. J. Exp. Biol.*, **32** : 679-681.

Craig, E.A. (1985). The heat shock response. *Crit. Rev. Biochem.*, **18** : 239-280.

Dalal, R. and Bhattacharya, Shelley (1991). Effect of chronic non-lethal doses of non-metals and metals on hepatic metallothionein in *Channa punctatus* (Bloch). *Ind. J. Exp. Biol.*, **29** : 693-694.

Garry, R.F., Bostick, D.A. and Ulug, E.T. (1986). Sindbis virus infection increases hexose transport in quiescent cells. *Virology*, **155**: 378-391.

Ghosh, N. and Bhattacharya, Shelley (1993). Acute phase response of rabbit to $HgCl_2$ and $CdCl_2$. *Biomed. Environ. Sciences*, **6** : 1-7.

Gray, M.A., Micklem, K.J., Brown, F. and Pasternak, C.A. (1983). Effect of vesicular stomatitis virus and Semliki Forest virus on uptake of nutrients and intracellular cation concentration. *J. Gen. Virol.*, **64** : 1449-1456.

Hayes, A.W. (1990). Principles and Methods of Toxicology. Raven Press, New York.

Landini, M.P. (1984). Early enhanced glucose uptake in human cytomegalovirus-infected cells. *J. Gen. Virol.*, **65** : 1229-1232.

Lindqvist, S. (1986). The heat shock response. *Annu. Rev. Biochem.*, **55** : 1151-1191.

Selye, H. (1946). General adaptation syndrome and diseases of adaptation. *J. Clin. Endocrinol. Metab.*, **6** : 117-230.

Warren, A.P., James, M.H., Menzies, D.E. *et al.* (1986). Stress induces an increased hexose uptake in cultured cells. *J. Cell. Physiol.*, **128** : 383-388.

□

HORMONAL CONTROL OF INSECT PESTS : PROSPECT

Sanjib Chakraborty

Department of Zoology, Kalyani University,

Kalyani - 741235, West Bengal

With the advancement of eco-physiological knowledge on insects, the intricacies of hormonal interplay during their development, in relation to the state of different environmental components, have gradually been unwrapped. The promising role of hormones/hormonal analogues has encouraged workers to brand such chemicals as the third generation pesticides. A long list of such chemicals, effective as insect population control agent, has, thus, come up (Nêmec, 1993).

Some of such compounds, e.g., Hydroprene (ethyl 3,7,11-trimethyl-2,4-dodecadienoate), Methoprene (isopropyl 11-methoxy-3,7,11-trimethyldodeca-2,4-dienoate), SJ-53-Fch (ethyl 11-chloro-3,7,11-trimethyl-2/E/dodecanoate), Fenoxycarb and Precocene-II (6,7-dimethoxy-2,2-dimethy;-2H-1-benzopyran), received as gift samples from abroad, were tested, following standard experimental protocols, one some insect pests, e.g., rice moth *Corcyra cephalonica*, stink bug *Chrysocoris stollii*, brinjal shoot and fruit borer *Leucinodes orbonalis*, green stink bug *Nezara viridula*, sunhemp caterpillar *Utetheisa pulchella*, jute semilooper *Anomis sabulifera*, rice stem borers *Sciropophaga incertulas*, *Chilo partellus* and *Chilo auricilius*.

The insects were reared upon their natural food in the laboratory under controlled conditions to get sufficient populations of different developmental stages. The chemicals, in different doses in acetone solution (1.0 µl/individual), were treated topically. Controls were run simultaneously. Results, obtained from subsequent developmental stages of the treated and control individuals, were examined and analysed.

The rate of development of different categories of moribund intermediate forms showed a

favourable point of the findings. The superlarvae of *A. sabulifera* and *U. pulchella*, thus produced, damaged increased quantity of plant tissues which, however, got minimized by the quantum of benefit secured in the next generation by low population build-up of the pest species.

Exploration on the physiological interaction in host-parasite relationship projected a doubt on the rationality of hormonal control of insect pests. The beneficial parasitoid (Hymenoptera : Braconidae) populations of *Bracon hebetor* and *Chelonus blackburni* were contaminated from their contact with hormones/analogues of hormones in the haemolymph of host larvae of *C. cephalonica* and showed significant non-viability through developmental derangements. Both embryonic and post-embryonic stages of the parasitoid were affected. The use of juvenoids in the field study is, therefore, not encouraging.

Selected References

Chakravorty, S. (1997). Physiological key to insect pest control programme. Uttar Pradesh J. Zool., **17**(2) : 127-132.

Chanda, S. and Chakravorty, S. (1998). Effect of stress on heart beat and post embryonic development in *Corcyra cephalonica* larvae. Indian J. exp. Biol., **36** : 796-799.

Chanda, S. and Chakravorty, S. Juvenilising effect and mortality in *Bracon hebetor* - a beneficial parasitoid bred on juvenoid treated host (*Corcyra cephalonica*) larvae. Indian J. Ent. (Communicated).

Nêmec, V. (1993). Juvenoids : from basic research to practical use. A short review. Boll. 1st. Ent. "G. Grandi" Univ. Bologna, **48** : 67.74.

□

CONVOY OF NEUROCRINE ELEMENTS IN INVERTEBRATES AND THEIR IMPLICATIONS

D.K. Nanda

Department of Zoology, University of Calcutta,
35, Ballygunge Circular Road, Calcutta - 700019.

There are shortcomings in the investigations of the nature and properties of invertebrate endocrine systems. These include, in the first place, small size of endocrine structures, lack of knowledge on the source and the nature of the active material despite physiologic evidence for the existence of invertebrate hormones. Secondly, majority of the invertebrate endocrine system is truly neuroendocrine with neurosecretory cells ("neuro-glandular" components) "neurocrine" elements, peptidergic" neurons etc. that play a decisive role in the its operations. In the third place morpho-anatomical position as well as the histology of the endocrine organs are often complex. Indeed endocrinology of vertebrates and invertebrates do differ in one important respect : many endocrine organs of vertebrate were described much before their function was known, where as the hormonal actions were detected in many invertebrates before the concerned endocrine tissues had been discovered.

Precise investigation on the endocrinology of many invertebrates hinges to special surgical methods for the removal of small glands (non-neural endocrine glands / structures) or to destroy relevant neurosecretory territories without damaging nervous system. Nevertheless, micromethods for the isolation of active principles out of small amount of material available are most demanding to determine the chemical nature of the secretion.

Majority of the endocrine investigation in invertebrates have been concerned with representatives of the largest phylum - arthropoda (insecta, crustacea etc.) and non-arthropods (annelids, molluscs etc.). Studies on the origin, chemistry and pharmaco-dynamic actions of the products of neurosecretion have significance but it must be considered within the framework of the overall ecology of the particular species in question. This will spell-out why the CNS includes organs of internal secretion (neurocrine elements) which, in some order of animals, are the main, if not, the only source of hormones. Several multidisciplinary appproach may disclose the complexities of the regulatory mechanism of the reproductive cycles in relation to neurosecretory activity in various insects, the role of the neurosecretory centres in the regeneration of annelids, ecdysis / moulting, pigment migration, photoperiodism, maturation of gonads, overall growth and development etc.

Recent in-depth studies clarify several points like neurosecretion, neuro-endocrinology and the biology of neuropeptides in general. Invertebrates, accordingly may be adjudged as "models"

for the study of peptide controlled biological processes. Circumstantial evidence through immunocytochemistry, radio-immuno-assay, electron microscopy and neurophysiology substantiate that the regulation of vital activities under neurosecretory control amongst candidate members of invertebrates is as sophisticated as that in vertebrates. Accordingly, it is reasonable to presume that the functional spectrum of neuropeptides ranges from neurohormonal through neuromodulatory to neurotransmitter like activities. Hence, the neutrocrine elements have a positive stand to assume "versatility" in all respects.

Selected References

K.C. Highnam & L. Hill — The comparative endocrinology of theh invertebrates.
A. Gorbman & H.A. Bern — A text book of comparative endocrinology.
H. Hellu & R.B. Clark — Neurosecretion.
H. Kobayashi, H. Bern & A. Urano — Neurosection and biology of neuropeptides.

□

SUSTAINABLE MANAGEMENT OF FARM ANIMAL RESOURCES TO ENHANCE PRODUCTIVITY FOR STRENGTHENING RURAL ECONOMY

D.N. Jana
Director of Research, Extension & Farms
West Bengal University of Animal & Fishery Sciences
68, Kshudiram Bose Sarani, Calcutta - 700037.

Farm Animal resources play an important role to provide employment and income to millions of rural population particularly to Landless, Marginal and Small Farmers. It is a very vital sector which contributes the gross value of out-put at current prices of about Rs.827 billion in 1995-96, amounting to 26% of the value of total out-put from agriculture sector. This excludes the contribution of Animal Drought Power.

India is endowed with vast animal resources of considerable genetic diversity. Over the time these stocks have developed capacity to withstand environmental stress and adopted themselves

in local condition. According to the livestock census (1992) the country possesses about 204.5 millon cattle (15% of world cattle population), 83.5 millions buffaoes (half of the world buffalo population), 50.8 million sheep (4% of world sheep population), 115.3 million goat (20% of world goat population), 12.8 million pigs and 307 million poultry birds. But due to indiscriminate breeding practice and unscientific use many of these valuable germ plasm are gradually dwindling. As a result, indigenous breeds of livestock are not available in plenty in original form. Moreover, Genetic diversity is a prime requirement for further improvement of the stock.

Conservation and improvement of animal germ plasm resources is very much essential to preserve bio-diversity. The country is endowed with vast livestock diversity among domesticated animals representing 26 breeds of cattle, 8 breeds of buffaloes, 40 breeds of sheep, 28 breeds of goats, 18 breeds of poultry and large number of non-descriptive animals in all species of livestock.

Sustainable use of natural resources is to be ensured to conserve bio-diversity. Sustainable use is the successful management of resources to satisfy the changing and growing human needs while maintaining or enhancing the quality of environment and conserving the natural resources for the future generations.

There is a tremendous potentiality to enhance livestock productivity of our indigenous stock in comparison to the developed breeds of livestock in the world. The average milk production of indigenous cattle is about 5000-6000 kg. per lactation for improved breeds like Holstein Fresion, Brown Swiss, Jersey etc. In case of poultry our indigenous birds lay about 60-70 eggs per year in place of 280-300 eggs per exotic birds per annum. There is a tremendous potentiality to improve the productivity of the indigenous stocks. Suitable breeding strategy shoulld be adopted scientifically to enhance animal productivity of our country and simultaneously effforts should be made to conserve the germ plasm for future use.

Animal resources not only produce the valuable products i.e. milk, meat, eggs, wool etc. but also give various by-products and waste which can be utilised and re-cycled for the welfare of the man-kind. Cow dung and other livestock waste can be suitably used for bio-gas production which provides fuel to millions of rural house-holds. This not only saves the environmental pollution but also protects the tree falling to a greater extent which are generally used for fuel woods. Again, the bio-gas slurry is a very rich manure to enrich the soil fertility for crop production. The monetary contribution from this account is about Rs.43.47 billion at current prices. There will be a acute crisis of fossil fuel supply in the near future. The sustainable use of cow dung and other animal waste through bio-gas production is very meaningful in this context. Our country presently spends about 70 percent of her export earning on oil import alone Similarly 80 million working bullocks provide 40 million horse power equivalent to 30,000 MW of electrical energy to rural sector for agriculture and allied operations. About 70 percent of fragmented crop area is cultivated by bullock ploughs. Twenty million of people are engaged in bullock cart operations in rural transport system.

Breeding strategy for cattle and buffalo and other small ruminants :

The following cattle breeding policy is under practice in India.

i) Selective breeding of pure Indian recognised breeds both for milk and draught.

ii) Grading-up of non-descriptive cattle with selective Indian breeds.

iii) Cross breeding of non-descriptive cattle with exotic donor breeds.

The policy of cross breeding was initially planned for non-descriptive cattle as foundation stock with limited exotic inheritance (50%). One generation of breeding of indigenous cow with the exotic breeds to create the F_1 cross-breds and then to breed the cross-bred among themselves. (Inter-se) to ensure a 50% exotic - 50% indigenous combination, enabling both endurance and productivity. The exotic donor breeds used were Jersey, Brown Swiss, Red dane and Holstein Fresian. The choice of exotic breed has now limited to Jersey and Holstein Fresian.

Initially cross-breeding was restricted to Hill areas and areas with pre-dominance of non-descriptive cattle. But due to overwhelming demand for cross-breeding among farmers, the initial restriction is no longer functioning. This resulted wide ranging cross-breeding in all the parts of the country involving all the breeds of cattle. This resulted in diluting and marginalising some of the Indian breeds of cattle i.e. Ongole, Nellore, Sahiwal, Red-Sindhi, Tharparkar, Gir, Haryana etc. which are under threat due to indiscriminate use of cross-breeding. This sort of cross-breeding is to be checked and the gentic diversity of our livestock resources is to be ensured.

In case of buffalo selective breeding of Murrah buffalo and grading-up of non-descriptive buffalo with Murrah breed are to be under-taken to enahnce productivity.

Sheeps in India are traditionally rare for meat and wool while goats are primarilly used as meat. Goats do produce some 4% of total milk production in the country. There are 20 breeds of goat and 40 breeds of sheep in India. The major objectives in breeding of sheep are improving the yield and quality of wool and meat. In goat the major objective is improved of quality meat and to a lesser extent to the milk yield.

The breed recommended as improver breeds for enhancing the desired quality in sheep are Marwari, Shahabadi, Musaffarnagari and Nali for wool production and Nelore and Mandya breeds for meat production.

In case of goat breeding - Jamunapari, Kutchi and Beetal are generally used for higher live weight and milk production.

Cross breeding of sheep to evolve new breeds for quality wool production is under trials. The exotic breeds used for this purpose are Suffolk, Dorset, Corriedal and Merino. Similarly in goat, Alpine and Saanan exotic breeds are generally used for cross breeding of goat for meat, and milk. As a whole the breeding strategy for the livestock should be such that the bio-diversity should be maintained while improving the productivity of our indigenous breeds of livestock.

The traditional animal husbandary is complimentary and supplementary to agriculture in

strengthening rural economy. The studies by the Institute of Rural Agricutural Statistics, New Delhi, on different farming system showed that mixed farming is more profitable than Arable farming. Investigation at Agro-economic Research Centre in Gujrat revealed that proportion of income from Dairying to total income is higher, in case of small holdings. Another study in Kaira District in Gujrat showed that Dairying alone contributed 56% of total income from Agriculture and allied occupation. Researchers at Punjab Agricultural University established that Dairy Farming generated almost double the income than from the best crop combination. Work at Nationall Dairy Institute, Karnal, revealed that milk yield per animal was higher for marginal farmers and land-less labourers as compared to medium and large farm. About 80 percent of milk production comes from the small, marginal and land-less category of farmers.

Integrated livestock farming with crop production and fisheries can increase the productivity through re-cycling the resources. livestock enterprises and crop enterprises in India are intimately inter-linked in Indian farming system and are complimentary to each other. Livestock provide farm power and manure to field for crop production and the cropping system provide the feed and fodder for the livestock. Livestock sector receive in-puts from many non-farming enterprises as well i.e. feed manufacturing/milling industry, feed additives, drugs, bio-logicals and pharmaceuticals/ chemical industry. Livestock also provide many raw materials to manyindustries i.e. blood, bones, offals, skin, hides, hoofs, horns bristles and hair to the pharmaceutical, leather and by-product industries. Thus livestock system has strong inter-linkage with many other systems.

Contribution of livestock sector to nationa income is substantial inspite of lower level of productivity. The share of agriculture in GDP was 52% in 1950 and declined steadily as the Indian economy diversified. The present contribution of agriculture is around 29% of our GDP. But the contribution of livestock sector, however, has remained steady around 8% at current prices and has gone-up to 9% in recent years.

As a source of employment generation, this sector plays an important role to rural sector. The livestock productionis predominently utilised the family labour specialy women. The rural employment in livestock sector has grown @ 4.25% between 1972 and 1988.

About 70 percent of livestock in India belong to 67 percent of small, marginal and land-less agricultural workers. About 40 percent people of our society are classified as those living below the poverty line, have a direct link with the livestock farming for their existence. To this deprived sector of people livestock are the only asset and livestock development programmes are likely to act as instrument of social change and justice.

Selected References

Acharya, R.M. and Bhat, P.N. (1984). Livestock and Poultry Genetic Resources in India. Indian Vety. Res. Institute. Izatnagar (U.P.).

Bhat, P.N. (1988). Presidential Address (Medical and Veterinary Sciences). 75th Indian Science

Congress, Pune, 1988.

Hand Book of Animal Husbandry (1990). Published by Indian Council of Agricultural Research, New Delhi.

India - 1988. Published by Publication Division, Ministry of Information and Broadcasting, Govt. of India.

□

CO-EVOLUTION IN INSECT PLANT ASSOCIATION

Samiran Chakrabarti

Department of Zoology, University of Kalyani,

Kalyani 741 235

Insects and plants share ancient associations that probably date from the carboniferous. The fossil evidence however suggests that the major taxa of phytophagous (plant feeding) insects became diverse only later, in the Cretaceous. At this time angiosperms (flowering plants) dramatically increased in diversity in a radiation that displaced the previously dominant plant groups of the Jurassic period.

Insect and plant association

Though lack of fossils as well as rapidity of diversification have cast a shadow on our knowledge about early evolution of angiosperm and insect pollinators, yet living representative of primitive beetles feeding on spores and pollens of non-angiosperms before angiosperm radiation show a probable line of preadaptation changing from feeding to pollination. As insects foraged more often for pollens, they became a more reliable transport system for plants and the simultaneous evolution of insect pollinators and flowering plants had began.

Besides pollination, another type of association between plants and insects is phytophagy or herbivory. The earliest true insects probably were scavenger in soil and litter and fed on decaying plant matter as also found in many modern insects and other arthropods. With the evolution, the insects became specialised to use plant aerial parts by sap sucking, leaf chewing and other forms of phytophagy. Feeding on living tissues of higher plants poses many problems that are not faced

either by the scavengers living in the soil or litter, or by predators. Firstly, a phytophagous insect must be able to remain attached to the plant parts in order to feed on leaves, stems or flowers. Secondly, the exposed phytophage may be a subject to greater dessication than the aquatic or litter-dwelling insects. Thirdly, a diet of plant tissue (excluding seeds) is nutritionally inferior in protein, starch and vitamin content when compared with food of animal or microbial origin.

Above all these barriers, the most important fact is that the plants are not passive victims of phytophages but have evolved a variety of means to deter them. These include physical defenses, such as spines, spicules or sclerophyllous tissues and chemical defences that may repel, poison or reduce digestibility or otherwise adversely affect insect behaviour or physiology forcing them to change themselves to adapt to the unfavourable condition for their own survival.

Co-evolution

Reciprocal interactions over evolutionary time between phytophagous insects and their food plants or pollinating insects and the plants they pollinate have been described as co-evolution. This term was coined and broadly defined by Ehrlich and Raven (1964) from a study of butterflies and their host plants. They also introduced the term 'Community evoluton' explaining the evolutionary interactions found among different kinds of organisms and considered 'Co-evolution' as a smaller subset of 'Community evolution'. However, now-a-days several modes of co-evolution are recognised differing in the emphasis placed on the specificity and reciprocity of the interaction.

Types of co-evolution

Two types of co-evolutions are now recognised. However, such classifications are well recognised in hervivory-plant interactions than in pollinating insect-plant interaction. **Specific** or **pair-wise** or **one-on-one** co-evolution refers to the evolution of a trait of one species in response to a trait of another species which in turn originally evolved in reponse to the trait of the first species. Mutualism occurs where both the species benefit each other and thus develop symbiotic relationship. If the effects are deleterious to any one of them (e.g. caterpillar and their host plants). then the relationship is antagonistic.

The other type of co-evolution known as **diffuse** or **guild co-evolution**. It described the reciprocal evolutionary changes among groups, rather than pairs of species. Here, the criterion of specificity is relaxed so that a particular trait in one or more species (of flowering plants, for example) may evolve in response to a trait or of traits in several different and perhaps unrelated phytophagous insects. The situation may be other way round. Like pair-wise co-evoluation diffuse co-evoluation may be antagonistic or mutualistic.

Process of co-evolution and some examples

In case of mutualism, since a stable condition is attained between the insect and the plant,

the possibility of further evolution in both of them is thus minimised. But in case of antagonism stability of relationship is not reached because the action of one of them is still offensive and that of the other is still defensive. So in antagonism the process of evolution in both of them is still in operation until an equilibrium is attained, i.e. mutation is necessary. When the co-evolution is continuous, as in case of antagonism, the result may be an evolutionary **'arm race'** between the insect, the action of which is offensive, and the plant the action of which is defensive. Thus ultimately new traits in both of them may appear who are perfectly adapted to each other. The insect gall on plantsis an example of such a stabilised antagonistic co-evolution.

Angiosperm-pollinator relationship is an intermix mutalistic and antagonistic co-evolution. The plant wants to ensure pollination at minimum cost. It therefore, produces little pollen and nectar as possible. The pollinator wants to maximise the reward from its visits. If another plant species offers a better reward to a pollinating insect, it will go to that plant. Thus different plants in a community compete among themselves for pollination. In tropical foreest a tendency to avoid this competition is found by flowering at different seasons. The diversity fo tropical forest is only possible because of the co-evolution of angiosperms with pollinators.

Within the general background of diffuse co-evolution there are examples of more specialied paired co-evolution between plant and pollinator species. Such as butterfly pollinated flowers have long corolla tube which matches the length of the pollinator's tongue. But examples of tight pair-wise co-evolution is very few (e.g. Gall wasp and fig).

Bergstrom (1968) suggests that at an early evolutionary stage *Ophrys* (Orchid) was visited by both males and females of a particular hymenopteran species. This would have been followed by a transitional stage in the co-evolution of the present relationship. The change may well have been triggered by male behaviour. Even a slight sexual stimulus presented by the flowers would lead to males spending more time at the flowers than females. This would mean that the males had a greater chance of picking up the pollinia and rubbing of pollen from pollinia already attached to them. This flowers which stimulated the males the most would be more successfu as they would be more likely to pass pollen on and be pollinated themselves. Evolution would then promote further improvements in the flower to attract males.

There are also examples where some insects also cheat and steal nectar without collecting or depositing pollens in course of co-evolutionary interactions with plants.

Selected References

Ananthakrishnan, T.N. (ed.) (1986). Dynamics of Insect-Plant Interactions. Entomology Research Institute. Madras.

Bergstrom, G. (1978). Role of volatile chemicals in *Ophrys*-pollinator interactions. pp 207-232. In 'Harbourne, J.B. (ed.) Biochemical Aspects of Plant and Animal Evolution'. Academic Press, London.

Bernays, E.A. (ed.) (1992). Insect-Plant Interactions. CRC Press, Inc. Boca Raton, Florida.

Chapman, J.L. and Reiss, M.J. (1992). Ecology - Principle and Applications. Cambridge University Press. Cambridge.

Erlich, P.R. and Ravan, P.H. (1964). Butterflies and Plants : A Study in Co-evolution. *Evolution*, **18** : 586-608.

Gullan, P.J. and Cranston, P.S. 91994). The Insects : An Outline Entomology. Champman & Hall. London, New York, Tokyo, Melbourne.

Krebs, C.J. (1985). Ecology. Harper & Row, Publs. New York.

Mattson, J.W., Levieux, J. and Bernard-Dagan, C. (eds.) (1988). Mechanisms of Woody Plant Defenses Against Insects - Search and Pattern. Springer-Verlag. New York, Berlin, Heildelberg, London, Paris.

Miller, J.R. and Miller, T.A. (eds.) (1986). Insect-Plant Interaction. Springer-Verlag. New York, Berlin, Heildelberg, London, Paris.

Thaomson, J.N. (1989). Concepts of Coevolution. Trend in Ecology and Evolution, **4** : 179-183.

□

COMPUTER AND BIOSTATISTICAL ANALYSIS

Biswatosh Sengupta

Deputy Director (Community Facilities)

Calcutta Metropolitan Development Authority

Statistics is no longer restricted to matters only related to the affairs of the State from where the name was originated. It is playing a very sinificant role in all sphere of our life. In a very narrow sense, to general people conception of statistics is nothing but numerical facts or data in the form of the raw figures or tables and charts or at most percentages or averages, etc. But really it is not merely a collection of some figures and their presentation, it is something more which provides scientific tools to analyse data and draw inferences from the world of uncertainty and from the experimental results of the scientific investigations from all branches of science.

In scientific investigation the first prerequisite is the systematic methods of organising the experiment and to collect information from the outcome of the experiment (observed data) then to

summarise them in a meaningful manner and to present those either in tabular or graphical form and finally to analyse the data so observed and to draw valid and legitimate interences. Here both statistical tools and computer applications help the researcher to draw reasonable conclusion in a scientific manner from limited observations providing different kinds of estimates of the parameters of which one is interested. Statistical methods have now become a part and parcel of any decision making process. The estimation of probable truth of any statement can only be judged by statistical assessments. The Chi-square test provides a versatile method for testing the agreement between the expected and the observed results. Regression analysis helps in determining degree of association and the probable mathematical relationships between the dependent and independent variables.

In all facets of biological researches both experimental and morphological, the qualitative approach has almost been replaced by the precise quantitative analysis. Biostatistics has assumed enormous importance to the investigators of the various disciplines of biological sciences. The refined and sophisticated statistical techniques have been able to draw more reliable and valid inferences and conclusion about important medical and bio-science researches when only a part of the data are observed. This article provides a few broad examples from bio-sciences indicating the types of statistical analysis that can be applied for and the use of computer to perform the tedious and complicated statistical computations.

Let me start with a blood report. Suppose the percentage of blood sugar (fasting) is 400 mg/ml. Doctor is worried since it is beyond the usual normal range of 65 to 120. Similarly when the percentage of hemoglobin is beyond the nromal reference limit i.e. 14 + 25 (i.e. outside the normal range of 11.5 & 16.5 percent), it is a matter of concern. What does those really mean or how does those ranges are fixed ? Actually the range is fixed on the basis of the measurement of blood sugar or hemoglobin percentages obtained from a large number of individuals of a specified group of people having age, sex, race and region matches and using the formula

$$\text{Estimate} \pm (\text{reliability coefficient} \times \text{standard error})$$

The two numeerical values thus obtained define an interval called an interval estimate, with varying degree of confidence depending on the choice of reliability co-efficient based on either the assumption of normality or other criteria. Generally we consider 1.96 as reliability coefficient which means that the probability of the estimated value will lie within the above interval is .95 under the assumption of normality. Even for data which are not normally distributed we may take the advantages of the Central limit theorem when the sample size is large (above 30). There are many assumption which are being taken in consideration while doing the actual problem. Suppose a researcher is interested in obtaining an estimate of the average level of enzymes in a certain population, takes a sample of (say) 10 individuals, determine the level of enzymes in each and

computes a sample mean of x=22. Suppose further it is known that the variable of intereest is approximately normally distributed with a variance of 45. An approximate 95 percent confidence interval for population mean (μ) is given by

$$x \pm 1.96 \times \sigma_x \qquad \text{i.e. } 22 \pm 1.96 \times (45/10) \text{ i.e. } 17.84 \text{ \& } 26.16$$

Degree of association between the AChE activity (μ moles of acetylcholine chlorides hydrolysed per mg tissue per hour) on body weight of Tilapia mossambica or interrelationship between many such pair of biological events can be studied with the help of correlation coefficient (r) and statistical significance of such correlation can be tested using the statistics given by the formula

$$t = r\ (n-2) /\ (1-r^2) \text{ with } (n-2) \text{ degree of freedom}$$

Simple linear regression analysis may be done to find the mathematical relation between the above variables and to predict the dependent variable with the change of independent variable. Multiple regression is useful either in finding the relation among the variables or in predicting the values of a dependent variable given values of two or more independent variables. The regression of serum cholesterol level on body weight and systolic blood pressure is a case of multiple model. The general expression of multiple regression is given by the following equation.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots + \beta_K X_K$$

where X_1, X_2, X_3, ... X_K are independent (predictor) variables and Y is the dependent (criterion) variable. β_0, β_1, β_2, β_3, ... β_K are called regression coefficients and determined by the method of least.square.

Test of hypothesis is a statistical aid in reaching a decision concerning a population by examining a sample from the population. A hypothesis my be defined simply as a statement about one or more population. Here testing may be related to single population meean, or the difference between two population means or paired comparison. For example the significance difference in the mean systolic blood pressure between normal individuals and renal ischemia patients can be studied using Z scores while the significant change in mean systolic blood pressure due to therapy with a vasodilator drug can be studied using t-test. The effectiveness of certain diet in reducing serum cholesterol or the effect of some drug in increasing sleeping hour or the behaviours of some species with reespect to some physical & clinical changes can be studied with the help of paired t-test.

To test the significant association between the observed frequencies and the expected frequencies, or to test the goodness of fit or to determine the association between two or more

attributes Chi-square test is of importance in many biological experiments. Postullate of Mendel's monohybrid ratio of 3:1 or Mendel's dihybrid ratio of 9:3:3:1 in plant breeding are most common examples of study using Chi-square test. Also to study the effect of concentration of pesticide in relation to mortality of fish in different aquaria Chi-square test is utilised using 2x2 contigency table. It is a test for independence of two attributes. Here we are testing whether the percentage of death in the higher concentration is significantly different from that of the lower concentration of both are independent.

Analysis of variance may be applied to ascertain the magnitude of contributions of the several components into which the data can be partitioned to the total variation. Suppose in a study of the effect of glucose on insulin release, specimens of pancreatic tissue from experimental animals were treated with five different stimulants and the amount of insulin released were determined. Now to study the differences among the five populations with respect to the mean amount of insulin released, ANOVA is done.

There are many other statistical procedures both parametric and non-parametric and several examples of biostatistical analysis. Now elt me switch over to some other aspect viz. Use of Computer in Biostatistics.

With the advancement of science and technology widespread appllication of computer has made a tremendous impact in all sphere of our activities and scientific investigations. Whether it is a space research, or What if anallysis in business, or Geographical Information System in spatial planning, or Data Base Management System in various activities, or any theoretical and applied researches, Computer is playing a very vital role in recent time. Computer can perfom most complicated and tedious calculations faster and far more accurately than any human expert can do with manual techniques. Thus its utility in any scientific research in general and statistical analysis in particuar is of great importance. Now a days it is not essential to perform the long and tedious statistical analysis by the bio-scientists. They can devote more time to the improvement of the quality of raw data which are the basic input of investigations. Many Statistical packages are available to them for performing most of the descriptive and inferental statistical procedures necessary in various studies including those belonging to bio-sciences. BMDP Statistical Software — Biomedical computer programmes of University of California (1975) is the most widely used statistical packages utiised by the Bio-scientists all over the world. Computers in Biology and Medicine, Computes in Biomedical Research, and International Journal of Biomedical Computing are several periodicals devoted to the current developments in the use of computers in biology, medicine and related fields.

Selected References

BMDP Statistical Software Munual; University of California, Berkely, 1993.

Chaudhuri, Sail Kumar (1974). Statistical Methods (A guide to Medical Research), Calcutta.

Daniel, Wayne W. (1978). Biostatistics : A foundation for Hath Sciences, 2nd Edition, John Wiley & Sons.

Das, Debojyoti & Das, Arati (1993). Statistics in Biology and Psychology, Academic Publishers, Calcutta.

Lewis, Avin. E. (1971). Biostatistics, Affiiated East West Press, New Dehi.

Misra, B.N. & Misra, M.K. (1993). Introductory Practical Biostatistics, Darbari Prakashan, Calcutta.

BIODIVERSITY — ITS MEANING, MEASUREMENT AND MAINTENANCE

P.K. Maiti

Former Joint Director

Zoological Survey of India, Calcutta

Rapid loss of Biodiversity is now a deep concern to every one due to appriciation of its social, economic and environmental impact. Keeping aside the spititual and aesthetic reward of Nature, man has been deriving colossal direct benefit from biodiversity in the form of food, medicine and industrial products and yet to get many more. Biological resources are dwindling out faster due to over exploitation beyond our need, extension of agriculture, urbanization, industrialization, anthropogenic pollution, etc. caused by dramatic increase of human population, Further, the introduction of high technology in the name of development ignoring the indigenous knowledge, man is instrumental to mega-extinction and threat to biodiversity and ecodisaster around. On the other hand, it is well known that in each ecosystem even some types of minor organisms have a niche to occupy and have a part to play for smooth functioning of such ecosystem. If the critical mass of organism is below the threashold level by such mega-extinction in any ecosystem, it may collapse in due course.

Realizing this Scientists are striving hard to save the living world through scientific method and understanding of our rich biodiversity. They have arrived at an unifying concept that the indepth study and assessment of biodiversity certainly provide certain clue of conservation which is based mainly on the knowledge and understanding of taxonomy, genetics and ecology.

The present talk devotes to discuss briefly as to what is biodiversity, how to measure it and what are the hypothesis explaining the pattern of biodiversity citing suitable examples of animal communities from India and abroad.

Concept

In conceptual thought diversity is the condition of having differences - varieties. Animal diversity refers to the varieties of types or taxa in a group or in a given area. A region with a number of different taxonomic units (species, genus, etc.) is said to be biologically diverse (biodiversity) and a taxon containing more species, genera, families, etc. is known as hyperdiverse (taxonomic diversity).

Hence, biodiversity may be defined as the study of variety and variability of genetic material, organisms and of ecosystem or community. This includes diversity within species (genetic), between species (organismal) and ecosystem (ecological). As such, it embrasses three levels of concept i.e. taxonomic, genetic and ecological aspects which are all considered in the assessment of biodiversity of a region or in a taxon.

Genetic Diversity— A species with inter population differences where each population gets genetically adapted to specific environmental condition is known to be genetically diverse i.e. genetic diversity of a species or variation of genes (base sequence) within a population. Each variety or population within a species contains unique genes which have unique ability to adapt against pollution or any adverse condition. When these variety or population of any species are under threat, the genetic diversity within the species is reduced which is really the ultimate source of our natural wealth.

Taxonomic Diversity — The second part i.e. organismal diversity (or taxonomic) is more concerned to the taxonomists and is referred to species diversity and its supra-specific categories, species diversity refers to the varieties of species within a region or in a taxon which is the fundamental unit of biodiversity study.

Ecosystem Diversity—The third part deals with the ecosystem diversity. This could be best understood in studying the community or species complex in various ecological niches within the between subsystems and ecosystems. Some authors are dissatisfied with the terminology of "ecosystem diversity" and prefer 'community' or 'ecological diversity' — since physical environment of ecosystem does not have a biological component. All these conceptual aspects will be discussed with suitable examples in the discussion.

Measurements

Biodiversity can be measured at any level from over all global diversity to ecosystem community, species, population, individual or even to genes within a single individual. Among all these, the species is taken as the fundamental unit of biodiversity. Species richness is the main

measure of biodiversity and higher level of extinction is the manifestation of biodiversity crisis. Many indices of species diversity have been formulated, the most commonly used is the Shannon-Weaver diversity index. But biodiversity does not mean only the number of species in a site or in a taxon which could be counted easily to provide a quantitative measure of diversity and allow comparison with other area or taxa. But all the species or higher taxonomic unit are of unequal phglogenetic divergence, ecological significance and conservation priority. The use of phylogenetic pattern studies based on cladograms help determining the uniqueness of taxonomic status and conservation creteria in comparison to related taxa.

Surrogacy Method — The rapid assessment of biodiversity based on collection and count of any species group (numerous species) in a site is difficult and too expensive. Consequently surrogacy or estimation of diversity based on counting of higher taxa, especially easy identifiable genera or families, is appreciated atleast for taxonomically less worked out groups.

Extrapolation Method — A major challenge of biodiversity study is to develop firmer estimates of species number in exceeding varieties of animal groups. Theoritical aspects of use of extrapolation to measure species richness are critically examined by many authors. They concluded that the simple ration of species to species, taxon to taxon, site to site etc. provides certain clue of estimation in different groups.

Estimation of Gene Frequency — Gene frequencies are the proportions fo the different alleles of a gene in a population. To have these proportion, total number of organisms with various genotypes in the population may be counted and the relative frequencies of the alleles involved may be estimated by using some mathematical model.

Measurement of Ecosystem Diversity — It is very difficult to measure, since the boundary of the community that form the various subsystem (or landscape) within an ecosystem is extremely confusing. For fruitful result, it requires laborious effort in the field.

Diversity Pattern : Hypothesis

The pattern of biodiversity would not be interesting, if the level of diversity were the same everywhere. Not a single process or theory can explain a phenomenon as complex as biodiversity. Understanding diversity requires deep understanding of many ecological, evolutionary, geographical and biogeochemical processes and how all these proceses interact. However, many theories and hypotheses are advocated to explain the diversity gradients which will be discussed with proper examples both from India and abroad. These are time theory; spatial heterogeniety; competition, predation and productivity hypothesis; latitudinal, altitudinal and peninsularity gradients, etc.

Selected References

Colwell, R.K. and Coddington, J.A. (1991). Estimating terrestrial biodiversity through extrapolation, p. 18-24, In Hawkworth, D.L. (Ed.), The Royal Society, Chapman and Hall, London.

Hawksworth, D.L. (1991) (Ed.). Biodiversity - measurement and estimation. The Royal Society, 140 pp. Chapman and Hall, London.

Maiti, P.K. (1990). Phylogenetics and Biogeography : a synthetic approach, Taxonomy in Environment and Biology. *Zool. Surv. India*, pp. 133-146, Calcutta.

Maiti, P.K. (1997). Methods of estimating insect components from habitat and nest in "An Assessment Manual For Faunal Biodiversity in South Asia: SARC, p. 160-163, Colombo.

Maiti, P.K. and Saha, N. (1998). Faunal Diversity in India : Isoptera, Zool. Surv. India, pp. 1-8, Calcutta (in press).

□

TEACHING - LEARNING PROCESS

J.N. Rudra

Former Professor, Presidency College, Calcutta

Introductory Observations

Constant flow of the "River-Knowledge" Tributaries (1) Science flow, (2) Humanities Stream.

Science flow :-

Model - Sunlight - VIBGYOR

Advances in any one displine - Zoology, together with all other related disciplines - integrated and inter-related to be considered with a Totalitarian attitude.

Points for Discussion

Refresher Course :

1) To keep pace with the Science flow.
2) Advances is to be 'spelt' as —
   a) Modification, Correction, Verification of existing data.
   b) Addition / or deletion.
   c) Refinement.

d) New out-look/approach/interpretation. Need-based — i) short term and ii) long term.

e) Purposive utilisation / Application through Teachers' — Refresher Course / Work shop / Orientation Course.

Advances ---> Resource person ---> Teacher ---> Student ---> A continuous process ---> Feed Back System

In view of the fact, that the present refresher course is intended for the Teacher Trainees, I have selected "Technic of Teaching" as my topic for discussion.

Points for Consideration

1) Type of Teaching -

A) Teacher Centric — obsolete. Selects a topic and pour that on the students

B) Student Centric — modern, scientific teacher becomes one with the students forming a team and Learn together the teacher acting as Leader. Feed back system, constant evaluation of students participation and teacher's successful transaction.

Guide alphabet - W-5

a) What, b) Why, c) Whom, d) How, e) How much.

Key Word - M.S.C.

M - must, S - should, C - could. Ex-Teacher = Mother

Check Word - PROJECT

P - Purpose, R - Resource, O - Organisation, J - Justification, E - Effort required/evaluation/ effect, C - Cost, T - Time.

Illustration :- Functional Anatomy of the vertebrates

Topic — Comparative functional Anatomy of Circulatory system - Integrated approach, with an eye towards Evolution (Evolutionary modification means change of blud print).

A) Fundamental influece / Basic impetus :

Upheaval of land mass ---> Regression of water ---> zonation

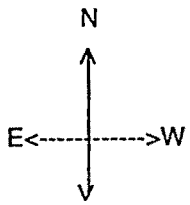
(a) Aquatic (Primary type), (b) Marshy (Transitional), (c) Hard land (Terrestrial - Secondary type).

B) Structures / Organs :

(a) Heart, (b) Arterial arches, Venous route, (c) Blood.

i) Erythrocyte — size, shape, membrane structure role in sodium, potassium and calcium balance mechanism (Alpha, Beta and Beta 2 cells (Calcium blocker).

Four Cardinal functions of Life —



N - Nervous system

E - Energy system

S - Supply system

W - Waste management.

Basic Impulse — Emergency of Terrestrial Vertebrates.
Aquatic ---> Transitional ---> Terrestrial.

Evolutionary modification — Change of the Blue print.

I. Heart

Key note : A. Condensation —
- i) Re-orientation
- ii) Absorbtion

B. Differentiation —

Result :
1) Primary heart - Fish
2) Transitional heart - Amphibia, Reptilia.
3) Secondary heart - Aves, Mammalia.

Aortic Arches.
Mechanism of Circulation. Single ---> Circulation, double circulation.

The main purpose of this study is to give a comprehensive idea about the integrated interrelationship between the other systems of the body and other disciplines, more particularly Chemistry, Physics and Mathhematics. A totalitarian attitude of the study is essential to develop the concept of an aggregated unit — the science flow.

□

FISHERY MANAGEMENT : TO-DAY AND TOMORROW AN INTROSPECTION

K.C. Mookerjee

Former Head,

Department of Zoology, Asutosh College, Calcutta.

[This lecture is dedicated to the hallowed memory of respected teacher Late Prof. H.K. Mookerjee in his birth centenary year.]

Water is a highway, by way, communication medium, nursing, play ground, school, room, bed, board, drink, tollet and grave for not only fishes but any aquatic life form. All vital functions like feedling, digestion, assimilation, growth responses to stimuli and reproduction are dependent on water. And India is one such country which is gifted with vast marine, as well as inland water resources.

Fishery in general can be referred to as the culture, capture, transport, preservations marketing and management of all important aquatic resources. Since, culture of economic important aquatic life forms, their increase in number does not face any constraints regarding space, water dependent cultures have been increasing with time.

In India human population has increased almost three fold after independence. Presently India has got 17% of the total world population, which is expected to increase further shortly, So, the need of the hour is to increase food as well as employment generation. Fishery can contribute a lot in this respect, though the alarmingly increasing trend of population growth has already started to destroy the waterbodies. Undue human interference through habitation, industrialization, pollution and other activities have contributed a lot to restrict the purview of fishery.

In a country like India, the application of fishery is manifold. It could be thought from many angles, from that of a biologist, aquaculturist, chemist, economist, sociologist, microbiologist and that of industrialists. Fishery, can be applied for increasing food production, particularly near consumer centres in rural areas to improve human nutrition; supplementing or replacing capture fishery production of over - exploited fish and shell-fish stocks; generating new sources of employment in rural areas; overall development of rural areas through intergrated projects including aquaculture, earning and saving of foreign exchange through import substitution; using wet land productivity and using organic wastes for food production and environmental management; sportfishing and home and public aquaria; agroindustrial development which could include processing and marketing of fishery products, feeds and equipment in aquaculture.

With the above mentioned reasons in mind various scientific, technological and management techniques have been applied like induced breeding, polyculture, introduction of exotic carps,

paddy-cum prawn culture, modern hatchery management, sewage fed fishery, shell-fishery etc.

Some of these have initially yielded good results but the impact - assessments have not yet been done. The chemicals we apply, the genetic manipulations we make, the high export potentials we think everything is bound to have an adverse effect on food chain and bio-diversity conservation. The diminishing trend of the so called 'TRASH' aquatic resources should be taken care of in the light of environmental management.

Finally it can be said that, resource management, applicability, sustainability, impact - assessment and genetic/hormonal manipulations should be taken into account and it should be thought in the light of "WELFARE ECONOMY' - everything may not be thought in the light of CAPITAL only.

We owe much to Prof. H.K. Mookerjee for his outstanding contribution in fishery though he was a hardcore embryologist. His foresight for developing fishery in India, West Bengal in particular, should be remembered by the posterity for all the time to come.

Selected References

Pillay, T.V.R. (1990). Aquaculture - Principle and Practices. Fishing News Books. A division of Blackwell Scientific Publisation Ltd., London.

Pillay, T.V.R. (1976). Advances in aquaculture. FAO Publication.

Shepherd, C.J. and Bromage, N.R. (1988). Intensive fish farming BSP Professional books.

Jhingran, V.G. (1991). Fish & Fisheries of India. Hindusthan Publishing Corporation (India).

□

SOME ASPECTS ON THE REGULATION OF GENE EXPRESSION

Tapan Kumar Pal
Department of Zoology, Vivekananda College,
Calcutta - 700063

Gene expression is the process by which the biological information contained in the gene is made available to the cell. All genes undergo the first stage of gene expression which is called transcription. During transcription the template strand of the gene directs the synthesis of an RNA molecule, the sequence of this RNA transcript being determined by complementary base pairing. For some genes this RNA transcript is itself the end-product of gene expression. For others the transcript undergoes the second stage of gene expression called translation.

Genes coding for enzymes such as RNA polymerase or those involved in the basic metabolic pathways are active all the time and are therefore called house keeping genes. On the other hand, many genes have more specialized roles and their biological information is needed by the cell only under certain circumstances. All organisms are therefore able to regulate expression of their genes, so that those genes whose RNA or protein product are not needed at a particular time are switched off.

Jacob and Monod proposed the operon model to explain the regulation of genes encoding enzymes required for lactose utilization in *E. coli*. Transcription of the structural genes is regulated by two controlling elements called the regulator gene and the operator sequence. Regulator genes code for proteins called repressors which function by means of their sequence - specific binding to DNA.

The prototype of negative control by way of an inducible operon is the lactose system of *E. coli*. Among the nonenzymatic proteins are the regulatory proteins that interact with specific DNA sequences to control the transcriptional activity of specific genes. The structural genes synthesize mRNA under the operational control of an operator gene. If there is no lactose, transcription of the lac operon does not occur because the promoter is blocked by the repressor. Transcription is induced by allolactose. Glucose controls the amount of CAMP in the cell, by inhibiting adenylate cyclase. By controlling the amount of CAMP in the cell, glucose indirectly regulates attachment of the CAP-cAMP complex to the CAP site.

Repressible operon typified by the trp operon code for enzymes involved in a biosynthetic pathway and are controlled by the product of that pathway. The trp operon also makes use of a completely different gene regulation strategy, called at tenuation which serves to finely tune expression of the operon. When tryptophan is scarce, attenuation is defeated and the operon remains active. This means that the control exerted by attenuation responds to tryptophan levels,

just as repression does.

The regulation of the arabinose or ara operon is also controlled by a positive and negative regulatory mechanism. The promoter for this operon (ara -BAD) si complex in that it contains a binding site for RNA polymerase, cAMP-CAP and ara-specific positive regulatory protein. Two positive regulatory proteins, P2 and cAMP-CAP are required to express the ara BAD operon.

Translation can also be controlled by the synthesis of small RNA molecules that are complementary to the initiating region of a specific mRNA. These small mic RNAs (mRNA inhibiting complementary RNA) hybridize to the shine -Dalgarno region of the mRNA and prevent binding of 30S ribosomes to this region. This effectively blocks the translantion process.

Eukaryotic cells respond to a greater range of regulatory stimuli. Individual cells respond to stimuli that originate from within the organism. Hormones, growth factors and other regulatory molecules are produced by one type of cell and cause changes in gene expression in other cells. Some eukaryotic genes are developmentally regulated. For example, human globulin genes, different members of the α and β genefamilies being expressed in the embryo, foetus and adults. Gene regulation in multicellular organisms results in cell specialization.

Control of gene expression is, in essence control over the amount of gene product. If either the synthesis rate or the degradation rate changes then the steady state concentration also changes. There are various steps in the gene expression pathway.

1) Transcription — Increase the transcription rate and there will be more gene product.
2) mRNA degradation — Increase the rate at which mRNA molecules are degraded and there will be less gene product.
3) mRNA processing — In eukaryotic mRNAs, events such as capping, polyadenylation and splicing are prerequisites for translation. Slowdown any of these processing events and the product synthesis will fail.
4) Translation — Control could be exerted over the number of ribosomes that can attach to a single mRNA.

Transcription of a gene can be regulated by a DNA binding protein that attaches to a site upstream of the gene. The human metallothionein gene can be cited as an example to illustate the role of upstream sites and DNA - binding proteins in gene regulation in eukaryotes. Metallothionein is a protein that protects cells from the toxic effects of heavy metals such as cadmium. Nine upstream sites are involved in expression of the metallothionein gene. These sites can be divided into four groups - the TATA Box, Upstream promoter elements (UPEs), Enhancers and Transient response elements - called Metal Response Elements (MRE) and Glucocorticoid Response Elements (GRE). When heavy metals are present the metal response sites are filled by regulatory proteins that activate RNA polymerase II. The metallothionein gene is switched on and metallothionein protein is synthesized. It is presumed that by having four metal response sites the

activity of the gene can be controlled with greater precision.

There are similarities between different DNA - binding proteins reflecting the fact that they perform similar functions. In helix-turn-helix structure, the aminoacids in the two helices make contact with mucleotides in the double helix, ensuring that a particular protein binds to its correct bacterial repressor proteins including the trp repressor, and the corprotein of λ bacteriophage. Other DNA binding proteins possess structures called Zinc fingers. Still other DNA binding proteins have leucine Zippers, TBP is a large multisubunit protein that recognizes the TATA Box of Eukaryotic genes, TBP is the DNA binding subunit of TF IID. Binding of TBP is required to form a preinitiation complex as a prerequisite to RNA polymerase binding.

When the Drosophila homeotic genes were studied it was found that each one contains a nucleotide sequence, 180 bp in length that is similar in different genes. Homeotic genes are responsible for the correct specification of body parts. Mutation of one of these genes, Antenna pedia, causes the fly to form a leg where the antenna should be. The homeobox is conserved DNA seuqence which encodes the DNA binding protein structure related to the helix-turn-helix, called the homeodomain. Thhere are at least 38 homeobox genes in the human chromosome. There is a cluster of at least nine homeobox genes on human chromosome 17 (the HOXB genes) that determine the structure of the central Nervous system.

Many trans-factors bind to sequence elements close to the gene but some bind to positive (enhancers) or negative (silencers) elements long distances upstream or downstream of gene. The transcriptional regulatory proteins in eukaryotes that bind to enhancer or promoter sequences are activator proteins that induce transcription. These proteins have at least two distinct domains of protein structure, a DNA-binding domain that recognizes thhe specific DNA sequence to which it should bind and activation domain that interacts with the other transcription factors and/or the RNA Polymerase to bring about an increased rate of transcription.

Mckay and Steitzhave proposed that the catabolite activator protein stabilizes its CAP-binding sequence in a left-handed conformation. They proposed that this right handed to left handed transition in the double helix unwinds the adjacent promoter and thus activates transcription of thhe adjacent structural genes.

The genetic control of morphogenesis is noow being dissected in *Drosophila melanogaster.* The master plan now seems quite clear : development is controlled by a cascade of regulatory genes each at the proper time and place to trigger the expression of the next set of genes in the cascade. Several transcriptional and translational mechanisms have evolved to regulate gene expression in prokaryotes. It is likely that a number of additional mechanisms will be uncovered in prokaryotes and particularly in Eukaryotes.

Selected References

Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R.H. (1995). Outlines of Biochemistry, 5th Edn.

John Wiley & Sons, Inc. Canada.
Gardener, E.J., Simmons, M.J. and Snustad, D.P. (1991). Principles of Genetics, 8th Edn. John Wiley & Sons, Inc. New York.
Lewin, B. (1997). Genes VI Oxford University Press, Oxford.
Lodish, H., Baltimore, D., Berk, A., Zipursky, S.L., Matsudaira, P. and Darnell, J. (1995). Molecular Cell Biology, 3rd End. Scientific Americans Books, W.H. Freeman, New York.
Sheeler, P. and Bianchi, D.E. (1987). Cell and Molecular Biology, 3rd Edn. John Wiley & Sons, Inc., New York.
Sinden, R.R. (1994). DNA Structure and Function. Academic Press.
Weaver, R.F. and Hedrick, P.W. (1997). Genetics, 3rd Edn. Wm. C. Brown Publishers, London.

□

APPLICATION OF BIOTECHNOLOGY FOR SUSTAINABLE AGRICULTURE : INTEGRATED PEST MANAGEMENT

N.B. Chatterjee
Department of Zoology, University of Calcutta
35, Ballygunge Circular Road, Calcutta - 700 019

The rapid pace at which researches are going on biochemical technology and genetic engineering, naturally call for an integrated approach to problems concerning insect pests and host plants. The revolution in Biology took place in the early 1950's with the researcer's understanding about how living systems are regulated by three specific types of macromolecules like nucelic acids and proteins, and with the discovery of the structure of DNA. The biggest impact of molecular biology on the agriculture and agroecsystem, precisely here the pest management technology came with the mastering of the tools and techniques for handling of organic macromolecules and genes which lend to the foundation of the concept of biotechnology and ecotechnology.

I. Integrated Pest Management :

There are many definitions for integrated pest management (IPM). Pest management is the

intelligent selection and use of pest control actions or tactics that will ensure favourable economic, ecological and sociological coonsequences (Raab, 1972). The practice of pest management has been described as doing the following : (1) determining how the life system of a pest needs upto be modified to reduce its number below thhe 'economic threshold level', (2) applying biological knowledge and current technology to achieve the desired modifications, and (3) devising proceedures for pest control suited to current technology and compatible with economic and environmental quality aspects, that is economic and social acceptance.

II. Sustainable Agriculture :

With a theoretical foundation in agroecology (Raab *et al.*, 1984; Altieri, 1987, Kogan, 1988) proponents of the sustainability concept for crop production have found great affinity with principles and approaches of IPM. Indeed, IPM provided both a conceptual approach and implementation paradigm for sustainable agriculture (Gliessmann SR, ed. 1990) IPM is the component of sustainable agriculture or agroecosystem sustainability with the most robust ecological foundation. Under the context integration in IPM would have three basic levels : level I, species/population level integration; level II, community level integration; level III ecosystem level integration.

The available techniques for controlling individual pests are almost inexhaustable and involve a wide range of applied science and technology. These are conveniently categorized in increasing order of complexity : Cultural methods, mechanical methods, physical methods, biological methods, chemical methods, genetic methods and regulatory method. By the year 2000 AD production of cereal crops is expected to rise to 186 million tonnes, that of pulses to 13 million tonnes, of oil seeds to 14.5 million tonnes and of fibre crops to 7 million tonnes. The losses by pests to these crops are expected to rise to 18.6, 2.3, 4.6 and 4 million tonnes respectively. Although it is impossible to avoid these losses completely, these can be reduced to a great extent. It is known that neither biocontrol measures nor, partial host plant resistance, chemical or mechanical antixenosis, nor antibiosis alone would control a pest, their combined action could offer the success.

III. Technological Frontiers :

The paper under review has, therefore, emphasized the following critical emerging biotechnological areas where pest management agriculture has made a big venture affecting the agroecosystem.

1. Manipulations at the biochemical level of insect host plant interaction by the application of natural products of plant origin and insect hormone analogues i.e. insect growth regulators. The works on the application of natural products as insecticides, and growth and reproduction inhibitors for pests have been dramatically progressed and the technologies have been applied for the extraction and application of active ingredients. Inhibitory function on postembryonic growth and

reproduction and insecticidal effect of three natural products of plant origin and J H analogue, Hydropene have been established by the author and his research associates (Chatterjee and Singh, 1992, 1997 and others) for four stored product insects, *Sitophilus, Thizopertha, Tribolium* and *Caryedon*, and spotted bolloworm, Earias in order of preference : Black pepper extract (*Piperine*), > neem seed *extract* (*Azadarachtin*) > seed extract of *Brassica nigra*.

2. Microbial pesticide : The soil bacterium, *Bacillus thuringiensis* (B_t) and the nucleopolyhedrovirus (NPV) or Baculovirus produce proteins which are toxic to the insects. The aim of genetic engineering of these microorganisms for use of insectides is to combine the pathogenecity of the bacterium or virus insecticidal action of toxin, hormone or enzyme.

Recombinant Baculovirus Insecticides : Recombinant gene technology has provided the most with the exciting new development in the area of the genetical control of insect pests. With the advent of recombiuant DNA technology and the recent development of rapid-action recombinant baculoviruses, interest in the field potential of these viruses for insect control has increased dramatically. The advantages and disadvantages of recombinant baculovirus insectides and importance of risk assessment studies of these genetically modified organisms will be discussed. Upon infection of the insect larva with the recombinant baculovirus the foreign protein is expressed. If this protein is toxic to the insect, the insect will die rapidly from the effect, rather than from the viral infection itself. The major baculovirus - expression systems have been developed for the production of recombinant proteins for research based on the nucleopolyhedrovirus derived from the alfalfa looper, *Autographa californica* (Ac NPV) and a similar virus from the silkworm, *Bombyx mori* (BmNPV). The sequences of the entire genome of both AcNPV and BmNPV hhave been now determined.

Insect Resistance of Bacillus thuringiensis (B_t Toxins) : Most B_t strains produce a number of related toxins, each coded for by a single gene (Lereclus *et al.*, 1993). Each toxin has a very specific target site within the insect (Gill *et al.*, 1992). Both the classical host-plant resistance and pesticide resistance literature indicate that toxic factors that impinge only on a single, specific target site may offer less of an evolutionary barrier than toxins with multiple effects (Green *et al.*, 1990; Norris and Kogan, 1980). Already researches have demonstrated the potential of insects to adapt to B_t toxins. The phhysiology of insect adaptation to B_t toxins is of fundamental importance to designing sustainable approaches for deployment of B_t based transgenic insecticidal cultivars (TICs).

3. Transgenic Insecticidal Cultivars : Fewer target exist for insect adaptation to TIC - produced B_t-because within a TIC, toxin is not expected to be in crystal form, and many of the B_t gene

constructs in transformed plants directly produce the active toxin moiety (Peferoen, 1992). Since 1996 genetically engineered cotton, corn and potato cultivars that expressed a gene derived from *B. thuringiensis* (B_t) were cultivated. This gene codes for production of a protein that is toxic to some lepidopteran pests of transgenic insecticidal cultivar of cotton.

Challenges :

The use of recombinant baculoviruses for insect pest control is a new and rapidly changing field. Several small scale releases have taken place and a toxin containing rec BV demonstrated the sensotive nature of the technology (Levidow, 1995). Clearly, some fundamental areas of BV ecology will require more research. Environmental, social and economic pressures are driving agriculture towards more sustainable methods of pest control. These will be acieved in part by improving peoples knowledge of *B. turingiensis* and baculovirus genetics, molecular biology and ecology to design effective natural B_t and TIC produced B_t, also effective recombinant baenlovirus (rec BV) insecticides with minimized enviromental impact. Impact evaluation is an integral part of te process by which the environmental and economic benefits promised by rec BV insecticides will be realised.

Selected References

Altieri, M.A. (1987). Agroecology. The Scientific Basis of Alternative Agriculture. Boulder, CO. Westview, 227 pp.

Bonning, B.C. & Hammoc, B.D. (1996). Development of Recombinant baculovirouses for insect control. Annu. Rev. Entomol., **41** : 191-210.

Gill, S.S., Cowles, E.A., Pietrantonio, P.V. (1992). The mode of action of *Bacillus thuringiensis* endotoxins, Annu. Rev. Entomol., **37** : 615-36.

Gould, F. (1998). Sustainability of transgenic insectidial cultivars : INtegrating Pest Genetics & Ecology. Annu. Rev. Entomol., **43** : 701-26.

Chatterjee, N.B. & Singh, K. (1992). Effect of Neem on stored product pest (Coleoptera) Proc. zool. Soc., Cal. 45 : 335-344.

Chatterjee, N.B. & Singh, K. (1997). Some changes induced by *Brassi nigra* formulation in two stored grain pests. Proc. zool. Soc., Cal., **50** : 44-49.

Gliesmann, S.R. ed. (1990). Agroecology : Research int e Entomological Basis for Sustainable Agriculture, New York : Springer. Ecol. Stud. **78** : 380 pp.

Green, M.B., LeBaron, H.M., Moberg, W.K. eds. (1990). Managing resistance to agrochemicals. ACS Symp. Ser. 421. Washington, D.C. Am. Cem. Soc.

Kogan, M. (1988). Integrated Pest Management. Theory and Practice, Entomol: Exp. Appl. **49** : 59-70.

Lereclus, D., Delecluse, A., Lecadet, M.M. (1993). Diversity of *Bacillus thuringiensis* toxins and

genes. In *Bacillus thhuringiensis*, an Environmental Biopesticide :Theory and Practice, P.F. Entwistle, J.S. Cory, M.J. Bailey, S. Higgs, eds., pp. 37-69. Chhichester, U.K. Wiley.

Levidow, L. (1995). The Oxford baculovirus controversy - safely testing safety ? Biosciences. 45 : 545-51.

Norris, D.M. and Kogan, M. (1980). Biochemical and Morphhological bases of resistance. In Maxwell F.G. and Jennings P.R. eds. Breeding Plants Resistance to Insects pp. 23-26, New York, Wiley.

Peferoen, M. (1992). Engineering of insect - resistant plants with *Bacillus thuringiensis* crystal protein genes. In, Plant Genetic Manipulationfor Crop protection, AMR Gatehouse, VA Hilder, D. Boulter eds. pp. 135-53. Oxon, UK : CAB. Int.

Raab, R.L., DeFoliart, G.K. and Kennedy, G.G. (1984). An Ecological Approach to Managing Insect Populations. In, Ecological Entomology. C.B. Huffker, R.L. Raab. eds. pp 697-728. New York : Wiley.

□

SUSTAINABLE APICULTURE THROUGH BREEDING OF BEES AND PRODUCTION OF MEDICATED HONEY

K.D. Mukherjee

Apiartist & Founder Secretary

Bee Keepers Co-operative Society, Vill. - Subudhipur, 24-Pgs(S)

Apiculture started in India during 1953-54 and in West Bengal during 1955-56 with the financial and technical aids from the Khadi Gramodyog Commission. In the same year 1.28 tons of honey was extracted from 800 bee hives. With the steady increase in honey production, the year 1990-91 had a total output of 9288 tons of honey from 10 lakh 61 thousand hives.

However, from the immediate preceding year, the Thai Sac Brood Disease (TSBD - a viral bee disease) exacted a boll of *Apis cerana indica* population; consequently, in 1993-94 the number of hives came down to 6 lakh 78 thousand with a concommitant reduction in honey yield to 5529 tons (R.P. Phadke and D.M. Wakhle, 1996). Apart from the death toll of *Apis cerana indica* in the conventional apiaries, the viral disease told severely upon the natural populations of *Apis dorsata*

and *Apis florea* as a result of which production of honey was decreased likewise.

A survey revealed that prior to the incidence to TSBVD, there were one billion *A. cerena indica* hives. In addition to this, the wild populations of *A. dorsata* and *A. florea* could add 20% of the total produce from their collections from jungles, bushes, cultivated fields etc. On the one hand, due to the attach of TSBVD, about 50% of the hives were destroyed, on the other due to the expansion of agriculture and aforesation, the floral production escalated (Mishra, 1995).

It has been observed in another survey that many entomophilous crops are required for cross pollination for their seed/fruit set. And cross pollination by bees is the most effective and cheapest method of increasing yield in the most of these crops (McGregor, 1976; R.C. Sihag quoted by 1996 Free, 1993). India has about 50 million hectares of land under bee dependent crops like oilseeds, legumes, Pulses, vegetables and fruits. Many of these crops require 3 to 9 bee colonies per hectare for adequate pollination. Taking minimum of 3 colonies per hectare, we may roughly estimate that about 150 million bee colonies are needed (CBTRI, Tech Bulletin No.10, 1975).

The Govt. of India appointed in 1976 National Commission for Agriculture. Along with the several urgent steps the commission emphhasized the importance of apiculture for the improvement and development of Agriculture. Their 1st suggestion was, "Every village in India should have at least one apiary with 10 colonies. Each colony yield, 5 kg of honey on an average at product for raising the yield further we need to improve the bee strain through green rearing. The improved strain must be disease-free (Mukherjee, 1996).

Contrary to the expectation of installation of 60 lakh hives in 6 lakh villages in India as per the directive of the Commission by 2000 A.D., unfortunately enough, the number of hives have gone down from 10 lakh to 5 lakh. Under these circumstances, we will have to, on emergency basis, practise apiculture as a cottage industry in order to improve upon our agriculture. This will on one hand help the unemployed young men and women to earn their livelihood through a practical training in bee-keeping of three months' duration with a meagre capital, on the other hand will save *A. cerena indica* from extinction.

It may be mentioned in this context that though in 1990-91 nearly 10 thousand metric tons of oney was procured, in the next three or four years the yield dropped down slightly. Presently, *Apis mellifera* is being reared in the Punjab on a commercial scale since 1980 and capacity of this species is 5 to 6 times higher than *A. cerena indica* in honey yield. The number of *A. mellifera* hives in Punjab now totals to 1 lakh (Phadke and Wakhle, 1996). With the introduction of *A. mellifera* rearing in other parts of India, the honey yield has exceeded ten thousand metric tons. Due to the demand of honey at home and abroad, the total produce, though, come to the market yet one-third of it could not come under the purview of AAG-Mark. Consequently, the producers can not sell this honey directly to the customers. As soon they are compelled to blend this honey with inferior staff and this in turn, produces an adverse effect in the market.

Honey collected by the apiculturists is gathered by the bees from the blossoms of Eucalyptus, mustard, orange etc. during winter and in this honey, percentage of glucose is more than that of fructose, consequently, it solidifies during winter and as a result is debarred from the AAG-mark stamp. In fact, except the higher glucose content, this honey is in no way inferior; rather people living in colder areas prefer this granulated form of honey than the liquid form. We can benefit ourselves in the following three ways by consuming this granulated honey :

1) In most of the collections, honey contains more than 20% of water, hence for processing it some indirect heat is applied which deteriorates-the quality of honey. Granulated honey, collected during winter, contains less amount of water hence can be stored round the year and consumed without processing.
2) Granulated honey, when its container is kept under sun or in hot water begins to melt but will not melt if sugar is aded to it. But, if sugar is added to in liquid honey, it will melt and this adulteration cannot be detected without laboratory test. Therefore, granulated honey proves that it is the pure form.
3) Now-a-days, we consume lots of fast food. During breakfast, we take jam and jelly with bread. These contain 80% cane sugar. It we can create awareness among the public for consumption of granulated honey, both the sellers and consumers will be benefifed. Moreover, if we mix this honey wit milk, extracts of medicinal plants, antibiotics etc. and feed the same to the honey bees, we may obtain honey of nutritive value.

The trained unemployed youth will benefit themselves if they try the methodology referred to above in item (3). In all probability, they will get healthier bees, more honey rich in nutritive value, more wax and last but not the least they will make more profit by selling their honey at a higher price (Mukherjee, 1998).

Selected References

Padke R.P. & Wakhle, D.M. (1996). Status of Bee keeping Industry in India : National Bee keeping experience Exchange Conference : 29-31 May 1996, Punjab Agricultural University, Ludhiana 141004. pp. 59-67.

Mishra, R.C. (1995). Apiculture : Prospect and Problems : The Hindu Survey of Indian Agriculture 1995. pp. 185-187.

M.C. Gregor, 1976; Free, 1993; Sihag, R.C. 1996. Pollination of Indian Crops : Present Status and Future Needs : National Bee keeping Experience Exchange Conference. 29-31 May 1996, 141004. pp. 37-40.

Central Bee Research and Training Institute (Pune) : Tecnical Belletin No. 10. Bee keeping Dpl, Khadi & Village Industries Commission Bombay - 56.

Mukherjee, K.D. (1996). Apiculture Theory & Practice Second Refresher Course in Zoology :

Dept. of Zoology & Academic Staff College, University of Calcutta. Z-23 Dec. 1996. pp. 24-28.

Mukherjee, K.D. (1998). Development of Apiculture. A New Perspective. Frontiers of Zoology. Proceeding of the Third Refresher Course in Zoology. C.U. 6-28 Feb. 1998. pp. 153-155.

□

WATER-BIRDS OF WEST BENGAL : BIOLOGY AND STATUS

Swapan Kr. Das

Department of Zoology, Asutosh College

Calcutta - 700 026

Introduction

Birds have fascinated mankind from the ancient time. But ornithology, the branch of Zoology that deals with various aspects of bird life has remained in the hands of amatuer naturalists for centuries. In India, the situation was not very different. During the Muslim and British regime, bird watching was carried out mostly by nontechnical persons. As a consequence, the available records mainly depict the prominent features and distribution of the bird species with a very little informations on their biology and status. In earlier times, before the Muslim invasion, informations on these particular aspects are even more fragmentary.

The credit of establishing Ornithology on a solid scientific platform in India goes to Dr. Salim Ali and his collegues. They, for the first time, launched the idea for a comprehensive study of the bioloy, status and range of Indian birds and framed necessary recommendations for the conservation of vanishing species.

Although a few separate accounts of the Indian water birds are available but their present status and distribution are not thoroughly assessed in recent times. In the present discussion, an attempt has been made to give an account of the water birds of West Bengal. Some important aspects of their biology are also incorporated. Their status is identified with a view of their effective conservation as a component of bio-diversity (ecodivesity) of the state.

Water birds and their bionomic classification

Many bird species depend on water bodies for foraging. These birds fall into three main

categories, viz., divers, swimmers and waders. Birds of the first category chase their prospective victims, usually a fish, under water. They may or may not be good swimmers. Conversely, the swimmers are usually not good divers as they collect their food from the upper stratum of water bodies. Some water birds are, however, expert in swimming and diving.

The waders differ from the other two types in their food gathering habit. They do not invade into the water pool and pick up their food items from the shallow margin. Both the divers and swimmers have webbing in their feet of varying degree which is absent in the waders. Nevertheless, a few waders like Jacana, have extra ordinary long toes which distribute the body weight to a larger area. This bird is, therefore, capable of walking on the unstable floating lily-pads at ease as they search for insects. The waders may again be perching or non-perching type while the divers are mostly of perching type. Another group of birds includes Terns and Gulls. These birds are expert fliers and have long soaring wings. They hover over the riverine systems tirelessly and pounce on their aquatic prey. When required they can swim in water without difficulty.

It should be mentioned that all the bird species which fish from water bodies such as ponds, reservoirs, marshes or rivers, are not included in the general category of 'water birds'. For examples, the Kingfishers or Ospreys are fish-eaters but they are not true water birds, and do not show adaptive modifications comparable to the typical ones, either.

Another much specialized group of water birds include Plovers, Rails and Snipes. These birds probe for crustaceans and molluscs on the mudflats. Although their feeding ground is same, competition for food gathering is minimized by their different size and structure of bills. They capture their prey usually sedentary and tubicolous worms, crabs or mussels from different levels of muddy substratum. They are shore birds in sensu stricto. These birds may be looked upon as a sub-category of waders.

Food and feeding habits

Water birds consume wide variety of food stuffs, such as fish, warm, crustaecans, molluscs, tadpoles or insects. A few species of ducks, such as Pintail, Common Teal, Wigeon, Red-crested, Pocharoi etc. take a considerable amount of vegetable matters. Their vegetable diet comprises succulent petioles, tender shoots and leaves, fruits and seeds of aquatic plants. Paddy grains, at the milk stage, are also consumed. Storks hunt on lizards and frogs from the surrounding terrestrial environs.

Many water birds are able to thrive on a mixed diet, that is aquatic animals as well as the plant matters. But species with a very much specialized food habit is not uncommon. Flamingoes, for example, strain out Zooplanktons (mainly crustaceans like shrimps) from water. Their bill is extremely specialized for the purpose. The long and much flexible neck of the bird assist in the process.

Water birds may also adopt the scavangerous habit. This is well illustrated by the Gulls.

Usually they feed on fishes. But they are also observed to take other food stuffs and garbages that are thrownaway from the country boats or ships.

Very often these birds are observed to move in small or large parties. Behaviour biologists have pointed out a direct relation between this gregarious behaviour and food catching efficiency. Thus in Flamingo, this efficiency is maximum when the group size is small, comprising 5 or 6 birds. The chance of getting food gradually decreases with the increase in the group size.

Goss-Custard (1977a) (in Mc. Farland, 1985) studied foraging in the Redshank, a wading bird that hunts for food along the sea-shore and on the mudflats. He found that when these birds are feeding exclusively on polychaete worms, they tend to select their food over a certain size and discard the smaller ones. This reflets the bird's foraging strategy to maximize energy profitability. That is energy yielded from the metabolism of food is far higher than the amount of energy expended for catching he worms.

A few birds like Cormorants are reported to swallow their own feathers that help in tritutition of food by functioning as the gizzard stone (gastrolith). Being predominantly fish-eater, they do not require pebbles which is necessary for seed eating species. Sometimes they also hunt in small parties.

Mukherjee (1969, '72 & '75) carried out an elaborate study on the food habits of water birds ofSunderbans (South 24 Parganas).

Breeding biology

Mating season of the water birds varied with the climatic condition in different parts of India. In West Bengal, they are seen to build nests in spring or summer months. But a few species, such as the Open-Bill Stork is seen to build the nest in monsoon. Painted Stork prefers the monsoon and winter as the nesting season.

Water-birds are usually monogamous, although polygamy is not unknown. Pairing bond seems to be strong enough in certain species like Brahminy duck, Spoon-bill etc. An elaborate premating courtship is reported from the Crested grebes, **Cranes** and Flamingoes. Breeding calls are loud in most species, such as **Storks** and **Cranes** but sweet and melodious in common teal and Wigeon.

Nests of these birds are untidy platforms of sticks and shoots arranged on medium sized trees. Certain species like Open-bill stork, select lofty trees like tamarind or sulk-cotton besides the water bodies as the nesting site. Most of these birds are gregarious, and are found to breed in mixed heronaries. Salim Ali (1979) reports that such heronaries comprise the nests of Carmorants, Egrets, Painted Storks etc. The Open-bill stork, on the other hand, forms the breeding colonies of their own kind.

Ducks and Geese build their nests in scheduled areas, usually surrounded by water. Banks of the marshes covered with weeds and aquatic grasses or a small island is selected as the

nesting site. Thus, the nests with eggs and nestlings are protected from the terrestrial predators. The nest is a depression on ground, usually a shallow one. The Grebes and Jacanas build floating nests on lilypads by placing some water weeds.

The Snake-bird (Darter) always nests in an island. The youngs of this bird are hatched in a nudicalous condition, and are therefore helpless. It is true for many other water birds which nest in protected areas.

The clutch size varies with species. In Flamingo, the clutch comprises 1 or 2 eggs; usually 3 eggs are laid by a female Pelican 3 and 4 by Herons and Storks while a large clutch of 10 to 12 eggs is usually white but it is pale blue in Cormorant, greenish blue in Darter and reddish brown in Spoon-bill. The colour changes from white to dark brown in Grebes.

Some birds like Heron, Spoon-bill etc. shed feathers from the under parts of the body to form a temporary 'brood patch'. This helps in the incubation process because thhe body temperature can pass directly to the egg clutch which is otherwise interrupted by feathers. A plumage of nesteing down (powdery down) is a characteristic of the babies. A strong parent-offspring bond is observed in many species of Ducks and Geese which was thoroughly studied by Konrad Loreuz.

At the time of incubation, birds are seen to disperse their body heat by panting. Pelicans cool off by swaying their gular pouch in a hot-summer day.

Migration

Aquatic birds fall into two broad categories : migratory and resident species. The migratory ones may again be divided into two sub categories viz., locally migratory which have the breeding ground and the wintering area, both of which are in this country, the true migratory species, on the contrary, came from the arctic and subarctic parts of Asia. The second group exhibits a strict discipline in the timing of arrival and departure from their wintering grounds of West Bengal. Their routes of migration is curiously fixed. Whether it is influenced by geophysical factors or by the constallation of stars and celestial bodies has remained largely disputed. Salim Ali, in 1950's secorded the regularity in migration of a Ringed Grey Wagtail, in Mumbai. This little bird visited a small lawn of that city each year arriving on almost the same date in September from its Himalayan breeding ground. It is presumed that the bird had to cover a distance of same 2,000 KM.

In West Bengal, the migratory species are Pelican, Goliath Heron, Flamingo, Bar-headed Goose, common Teal, Brahminy Duck, Sheldrake, Wigcon, Plovers Pintails. Pochards etc. The resident water birds are Herons and Egrets, Little Grebe, Cormorant, Large Whistling Teal, Cotton Teal, Com Duck, Rails, Crakes, Moorhen, Jacana, Storks etc. Of 540 bird species of W.B. a majority are migratory.

Status & conservation

Most of the water birds are considered to be threatened species by IUCN (International

Union for Conservation of Nature and Natural Resources). A few birds species like Goosander, Snew, Pelican, Flamingo, Goliath Heron, Swanp Partridge etc. are either rare or locally exterminated from West Bengal. Mitra (1957) reports the existence of Pink-headed Duck and white Winged Wood Duck from undivided Bengal. The former species is now extinct and the latter one is one the verge of extinction and is now confined to very small areas in Assam.

Naturalists opine that the following factors are chiefly responsible for the decline in the aquatic avifauna.

1) Reclamation of the water bodies for agricultural purpose, development of additional townships etc.
2) Loss of suitable habitats required by the birds as shelter or as nesting places.
3) Increased and unplanned urbanization leading to a dramatic increase in the pollution loads encompassing air, water and noise pollutants.
4) Eutrophication and other qualitative changes of the water bodies (wetlands) resulting in the loss of biodiversity of the phyto- & zooplanktons.
5) Accumulation of insecticides in the birds' body, from the contaminated water through the food consumed, leads to the impairment of reproduction, spoilage of eggs by thinning of the egg shells, enhanced mortality of the youngs etc.
6) Poaching of birds.

Naturalists and ornithologists recommend for the protection of the water bodies, such as lakes and reservoirs in order to conserve the resident water birds *in situ*. Efforts should also be made to improve the environmental quality in the areas that are chosen by the migratory species as their wintering grounds. Certain measures have already been taken, and places liek Kulik in the Raigung District, Santragachi in the Howrah District, Brace Bridge in South 24 Parganas and the Sundarban Biosphere are declared as the protected places.

The following table accounts for the biology and status of the water birds of West Bengal.

Table 1 : Biology & Status of Water-birds.
Ex = Extinct; LE = Locally exterminated; T = Threatened; R = Rare; I = Indefinite; V = Vulnerable; C = Common; VR = Very rare; SW = Saltwater marsh; FW = Fresh water bodies; Ri = River; Es = Estuarine; HS = Hill streams; D = Divers; S = Swimmers; W = Wading in water; SB = Shore bird; F = Fish eating; In = Insectivorous; P = Plankton strainer; Vg = Vegetarian; Om = Omnivarous; O = Solitary; OO= In pairs; [] = In flocks. --> Migratory; + = Resident; ± = Locally migratory.

English & Scientific Names	Category & habitat	Nature	Status
A. Order Podicipediformes			
1. Indian little grebe *Podiceps ruficollis*	D; FE : OM;	OO / [] +	R

2. The crested grebe *Podiceps cristatus*	Same	Same -->	I
B. Order Polecaniformes			
1. Indian large cormorant *Phalacnocorak carbo*	D & S; FW & R; F	O / [] +	R
2. Little Cormorant *P. niger*	Same	Same	V
3. Indian - Darter *Anhinga melanogaster*	Same Sa	O +	R
4. Spotted-Pelican *Pelecanus philippensis*	S; FW & SW : F.	[] -->	Very Rare
C. Order Ciconiformes			
1. Grey Heron *Ardea cinerea*	W; FW & SW & R; F	O +	R
2. Giant heron *Ardea goliath*	W; ES; F	O -->	LE
3. Purple heron *A. purpurea*	W; FE, SW & R; F.	O +	C
4. Pond heron *Ardeola grayi*	Same	Same	C
5. Little green heron *Butorides striatus*	Same	Same	R
6. Night heron *Nycticoran nyctocorak*	Same	Same	R
7. Yellow bittern *Ixobrychus cinensia*	Same	Same	C
8. Chestnut bittern *I. cinnameneus*	Same	Same	C
9. Black bittern *I. flavicollis*	Same	Same	C

10. White Threskiornis nethiopica	Same	[] +	V
11. Black ibis *Pseudibis papillosa*	Prefers diving In & Rept.	[] +	R
12. Spoon-bill	SW & FW; W; Prog-Rep & vig	O []	V
13. Painted stork *Mycteria leucoçephala*	FW; W; F & (frogs)	OO / []; +	V
14. Open bill stork *Anastomus oscitans*	FW; W; In (frogs, crabs)	OO / []; +	V
15. White necked stork *Ciconia episcopus*	FW; W; In (frog, Liz).	[] -->	R
16. Black Stork *C. .nigra*	Same	[] -->	R
17. Black necked stork *Ephippiorlynchus asiaticus*	FW & R; W; F	O +	R
18. Flamingo *Phoenicopterus roseus*	FW & SW (Tidal mudflat) W; P	[] ±	R & T
D. Order Anseriformes			
1. Bar headed goose *Anser indicus*	S; R, Vg	[] -->	VR
2. Common whistling teal *Dendrocygma jayanica*	S; FW; F (frogs, snail)	[] +	R
3. Large whistling teal *D. bicolar*	Same	[] +	VR
4. Sheldrake *Tadorna tadorna*	S; FE & SW; Crabs & Snails	[] -->	R
5. Pintail *Anas acuta*	S; FW; Vg	OO / [] -->	C

6. Common teal *A. ereca*	Same	[]	R
7. Mallard *A. platyrhynchos*	Same	Same	VR
8. Gadwall *A. strepera*	Same	Same	VR
9. Wigeon *A. penelope*	Same	Same	R
10. Garganey *A. querquedula*	Same	Same	R
11. Shoveller	'Same except feeds on animals S & D, FW; In (frogs, crabs)	OO / []	C
12. White-eyed pochard *Aythya ovyroca*			
13. Tufted Pochard *A. fuligula*	Same	Same	R
14. Cotton teal *Nettopus coromandelianus*	Same; Vg.	[]	C
15. Comlo duck *Sarkdiornis melanotos*	Same; Vg.	[]	VR
16. Goosander *Mergus merganser*	S & D; HS; Om	OO -	VR
E. Order Gruiformes			
1. Indian Water rail *Rallus aquaticus*	FW & R; SB; S & D; Om	O -->	R
2. Banded Crake *Rallus eurizonoides*	Same	O +	R
3. Brown Crake *Amaurornia akool*	R; SB	O +	C

4. Whitebreasted waterhen *A. phoenicurus*	FW; SB; Om	O +	C
5. Waterhen Or Kora *Gallicrex cinerea*	Same	Same	C
6. Indian moorhen *G. choloropus*	Same	Same	C
7. Indian purple moorhen *Parphyrio porphyrio*	Same	Same	C
8. Coat *Fulica atra*	Same	Same	C
F. Order Charadriiformes			
1. Pheasant-tailed jacana *Hydrophasianus chirugus*	Same	Same	C
2. Bronze-Winged jacana *Metopidius indicus*	Same	Same	C
3. Indian Stone Plover *Burhinus ocdicnemus*	R; SB; Om		
4. Golden Plover *Pluvialis dominica*	R. SB &	OO / [] +	R
5. Eastern Curlew *Numerius arquta*	FW & SW :	OO / [] +	C
6. Common red shauk *Iriuga totanus*	Same	O / ±	C
7. Grcan shauk *T. ochropus*	Same	O /	R
8. Green Sandpiper *T. ochropus*	Same	O /	R
9. Common Sand Piper *T. hypobucos*	Same	"	C
10. Pintail snipe *Gallinago steuura*	FW & SW; W; In	O -	C

11. Fantails snipe *G. gallinago*	Same	Same	C
12. Tenminck's stint *Caliolrica temainckii*	FW; W; In		R
13. Brown headed gull *Larus brunnicaphalus*	SW & R; D (Sky); F (and garbage)		C
14. Black headed gull *L. ridibundus*	Same	Same	C
15. Whiskered teru *Chidonias hybrida*	FW, SW; R & ES; (Sky); F (tadpoles & Crabs)	Same	C
16. Indian river tern *Sterua aurantia*	Same	Same	C

Selected References

Ali, Salim (1979). The book of Indian birds. Bombay Natural History Society.

Bhusan, B. *et al.* (1993). A Field guide to the water birds of Asia. Water bird society of Japan.

Finn, F. (1920). How to know Indian Waders. Thaker, Spink & Co.

Laha, S.C. (1935). 'Jalachari' (in Bengali) Gurudas Chattopadhyay & Sons.

Mc. Farland, D. (1985). Animal Behaviour, Arnold-Heineman.

Majumder, N. *et al.* (1992). Aves; Fauna of West Bengal; Part I Z.S.I.

Mukherjee, A.K. (1969, 1972 & 1975). Food habits of water birds of Sundarbans, 24 Parganas district, West Bengal, India. J. Bombay nat. Hist. Soc., **66**(2) : 345-360; **68**(3) : 691-716 & **71**(2) : 188-200.

Mitra, S. (1957). 'Banglar Shikar-Prani' (in Bengali). Govt. of West Bengal.

Roy Chowdhury, D.K. (1984). Birds in and around the Calcutta Metropolitan Area. Naturalist, **I** : 7-16.

Soothhill, E. & Soothhill, R. (1989). Wading birds the world. Blandford.

Woodcock, M. (1980). Collin's Hand guide to the birds of the Indian subcontinent, Collins.

C.S.I.R. (1990). The Wealth of India; Raw materials. 2B; Sup : Birds. Publication and Information Directorate; C.S.I.R.

□

CANCER — A MUTATION-DRIVEN PROCESS

Samar Chakrabarti
Cancer Cytogenetics Unit, Zoology Department,
Burdwan University, Burdwan 713 104, WB.

Cancer is a distinct type of genetic disease in which several mutations are involved. Each mutation drives a wave of cellular multiplication associated with disorganization, invasion and metastais, the three basic attributes vital to malignancy. In this multistep process key proteins which regulate cell proliferation and apoptosis are frequently altered or over-produced.

One of the most significant developments in oncology over the past decade has been the proof that cancer is, in essence, a **genetic disease**. Unlike other genetic diseases, cancer is, for the most part, caused by **somatic mutations** only. Moreover, each individual cancer arises **not** from a single mutation but from the accumulation of several mutations. This multi-mutation, multistep concept is central to understanding neoplasia.

Cancer has no comprehensive definition. It is said to be a multiple disease. Each cancer has symptoms of its own. But one thing they all have in common is **uncontrolled** monoclonal proliferation of cells. Cancer cells are 'misguided cells'. They accumulate in the system much like 'anti-social elements' in a well organized society of normal cells. The 30 trillion cells of normal human being live in a complex interdependent condominium regulating the entire body function in an orderly way. Cancer cells, in contrast, violate this basic norm. They become 'deaf' to the usual control of cell proliferation and flow their own 'hidden agenda' resulting in an accumulation of unwanted cell mass called **tumour**. Some of these tumor cells has their contact inhibition property and become anchorage independent. They forget to obey Hayflick's limit and become deaf to all apoptotic signals. Some of these cells acquire the ability to migrate from their tissue of origin and invade the neighbouring organs to develop malignancies. Cancer cells are gifted with a number of enzyme batteries which constitute their metastatic cascade. Not all tumour cells that float away from their tissue of origin can reach the final destination. Many of these cells undergo apoptosis or programmed cell death on their way before forming new colony in neighbouring tissue or organ. Cells that have acquired sufficient mutations inflicting vital cell cycle regulatory genes can only metastasize and form secondary tumours.

According to **multi-hit model** of carcinogenesis, tumours grow by a process of clonal evolution driven by mutation. The **first mutation** would result in the limited expansion of the progeny of a single cell. One of these cells would later acquire a **second mutation**, perhaps allowing growth of a small benign tumour. One cell within this benign tumour would then undergo a **third mutation**,

overgrow its sister cells and form a more advanced tumour with multiple mutations. Eventually the cell will accumulate additional mutations to make it malignant, enabling it to invade surrounding tissues and metastatize to other organs. In this sequential multi-hit event three to seven hits are required for a cancer to form.

In current dogma of carcinogenesis, every human being carries a set of genes (**protooncogenes**) that can trigger and promote cancer if expressed inappropriately at a wrong level or in a wrong cell lineage or at a wrong stage of differentiation. These protooncogenes are highly conserved household sequences involved in the regulation of the cell cycle. Normally they encode growth factors, surface receptors, signal transducers or transcription factors. They may favour tumour development after undergoing certain structural or regulatory changes. These changes may lead to an illegitimate activation of growth factors, faulty signal transmission or to constitutive activation of transcription and/or DNA replication stimulating genes. Almost always the protooncogene that has altered in malignancies, is a gene involved in cellular proliferation, differentiation and survival. Genes involved in housekeeping function do not become oncogenes. However, a house keeping gene may become the fusion partner of protooncogenes.

Another kind of cancer related gene, the **tumour suppressor gene** has also been identified. The loss or inactivation of these growth suppressor genes through deletion or point mutation (or methylation) from a cell may remove a normal constraint on its growth. Such a deprivation may deregulate the proliferative machinery of a cell and the deprived cell may go away. Oncogenes studied to date are invariably activated through **somatic mutations** i.e., genetic alterations occurring only in the target tissue but not affected the germ cells. Activated oncogenes are, therefore, not inherited. In contrast, inactivated forms of tumour suppressor genes are found in germ cells. A child inheriting an inactivated tumour suppressor gene would have a greater lifetime risk to develop cancer.

The creation of a single oncogene may be necessary for the genesis of a particular tumour, but it is far from being sufficient. Tumorigenesis in reality is a **multistep process.** While oncogenes turn on cell division, tumour suppressor gene switches the process off. Much of the research on human cancer has centered on tumour suppressor genes which are **negative regulators** of cellular proliferation and teir inactivation by mutatioon results in the lss of a crucial 'brake' on tumour growth. These genes may be mutationally inactivated in the germ line, resulting in hereditary predisposition to tumurs, or more commonly, undergo somatic mutation, leading to initiation or progression of sporadic tumours. In their normal forms both protooncogenes and tumour suppressor genes work as a team, enabling the body to perform a number of vital functions as replacement of dead cells or repair of the defective ones. But alteration in their genetic make up (whether inherited or acquired later in life), can disrupt this finely tuned counter-balancing device. The altered and defective genes then function in concert to create full-fledged malignant growth.

The genes presumed to be important in the pathogenesis of cancer may be activated or

altered by several different mechanisms. Structural alteration of a proto-oncogene to generate an oncogene whose protein product acts upon the host cell to induce characteristics of malignancy is of common occurrence in human cancer. In general structurally altered oncogenes exert a **dominant** effect that overrides the effect of the residual normal allele. The genes which are frequently involved in malignancy are : **i.** genes for growth factor receptors; **ii.** genes responsible for signal transduction; **iii.** genes which respond to cell prpoliferatin signals; **iv.** genes involved in tissue differentitation; **v.** genes involved in apoptosis, and **vi.** tumour suppressor genes which normally function to limit cell proliferation.

Some genes and gene families are more frequently involved in the pathogenesis of human cancer. The **ras** genes belong to a large superfamily with 50 members. The **ras** genes encode guanine-nucleotide binding proteins that function in transduction of mitogenic signals from a variety of GF receptor. The **ras** genes become oncogenic as a result of point mutation in codons 12, 13, 59, 61 and 63 of its members N-**ras**, K-**ras**, and H-**ras**. The mutation characteristic of **ras** oncogenes has the effect of maintaining the **ras** proteins constitutively in the active GTP-bound conformation which facilitates unregulated cell proliferation. The **abl** oncogene is another gene responsible for a signal transduction. In normal position **abl** encodes 160 KDa **ABL** protein which has moderate tyrosine kinase activity. Ph' translocation results in the formation of **bcr-abl** fusion gene which potentiates its tyrosine kinase activity by the production of a large 210 KDa fusion protein which is thought to be an early event in the induction of chronic myelocytic leukemia. The **myc** oncogene product functions as transcription control element which interacts with other cellular proteins to bind to a consensus sequence of six DNA bases and thereby influences the expression of other genes involved in cellular proliferation. The **bcl**-2 oncogene is involved in the regulation of apoptosis. The $\mathbf{p^{53}}$ tumor supressor gene is widely mutated in various human malignancies. About 55% human cancer display either a mutated or deleted $\mathbf{p^{53}}$ gene. It is said to be the **'guardian of the genome'** and a nuclear phosphoprotein encoded by this gene plays a crucial role in cell cycle regulation.

Selected References

Adams, M.J. and Cory, S. (1998). The Bcl-2 protein family : arbiters of cell survival. Science **281** : 1322-1326.

Chakrabarti, S. (1998). Cancer Gene : the enemy within. In : Frontiers of Zoology. Ed. S. Chakraborty. Publ. ASC, C.U. pp. 85-87.

Laired, P.W. (1997). Oncogenic mechanisms mediated by DNA methylation. Mol. Med. Today. pp. 223-229.

Thomas, N.S.B. (1996). Apoptosis and Cell Cycle Control in Cancer. Bios. Sci. Publ. Oxford.

Vogelstein, B. and Kinzler, K.W. (1993). The multistep nature of cancer. TIG : **9** : 138-141.

□

HELMINTH MAN INTERACTION

A.K. Bandyopadhyay
Associate Professor & Head (Retd.)
Department of Helminthology,
Calcutta School of Tropical Medicine

Association of helminths with man has been known since the early days of civilization. They have been described in Sanskrit as "krimi", in Greek as "helmis", in Latin as "vermis" and in German as "wurm". In 'Ayurveda' (the fifth veda) (2800-2700 BC) diseases caused by 'krimi' — their clinical features and management have been well documented. Description of filariases (sil padam) in 'Susruta-sanhita' is in no way less clear than that as depicted in latest tex-book of medicine. But as the Hindu system of recording was mainly based on 'shruti' and 'smriti' the writing in paper is lamentably lacking. Hesslar in his Latin translation of 'Susruta sanhita' assigned the appearence of these works to remote period of Indian history the 'beginning of which is lost in the immensity of time and the end of which is known to be about 1000 BC'. In Old Testament there is mention of Guinea worm (*D. meadinensis*) along with its safe method of extraction. Heppocratis (460-377 BC) described beaf tape worm (*T. saginata*) and hydatid infection (*Echinococcosis*). Large round worm (*A. lumbricoides*) and guinea worm have been mentioned by Aristotle (384-322 BC). Heoppli (1959), as quoted by Waren, observed that helminths are the first infectious agents known, as they were clearly visible to the human eyes. He further pointed out that primitive tribes of Sarawalk and North Borneo were familiar with intestinal worms.

Helminths found in man are potentially pathogenic. From the stage of "peaceful co-existence" (i.e., apparently a symptomatic stage) to very explosive nature of clinical expression may be found with helminthic infection. This may be due to host's (man) worm burden, frequency of exposure to infection, health status, immune status etc.

All the categories of helminths nematodes, cestodes, trematodes have been recorded in man. Man may harbour adult stage of worms (definitive host), their larval stage (intermediate host) and with some both adult and larval stages can develop. As a paratenic host man will allow the entry of larval stage of helminth but not allow their further development - but keep the invading potentiality intact.

Another type of host system may develop in man where man acting as an incompatable host will not allow full development of the worms following their entry in man. The migrating parasite (the nematode larva) may be arrested at different levels (organs) and ultimately will die. But before their death baneful impact will be in bizarre clinical expression (larva migrans - visceral and cutaneous). This situation is also termed as occult parasitosis — as the detection of causative agents (helminths)

is extremely difficult.

Host's reaction in the form of clinical expression is dependant on the stages of parasites (larval, adult), their number, host's organ involved, host's immune status (inert, hypersensitive etc). There is not much specific clinical signs and symptoms in relation to class (nematodes, cestodes, trematodes). Helminthic infections seldom have dramatic explosive character like malaria, kala-azar (due to protozoal counter part) or viral and bacterial offenders. But this lack of dramatic expression is well compensated by their relentlessly corrosive impact on the human population collectively, extensively and perennially. Many of helminthic infections, e.g., hookworm infection, filariasis, schistosomiasis, hydatidosis, producing in capacities and disabilities on a massive scale exact a devastating economic toll — progressively, and perpetually in the endemic areas of the world. Public health importance of various helminthic infections, (e.q. intestinal helminthiasis) continues because of their high prevalence vertually to third world global distribution affecting both nutritional and immune status of population. These effects are of obvious significance in under-nourished population, where utilization of food is poor and inadequate. Immune suppression may also lowers the resistance of such population to other infection(s) and render active immunization process less effective. Helminthiasis, specially in children, may affect their physical and mental development.

The major helminthiasis in man are caused by intestinal helminths, where ultimate lodgement of worms occurs in gastro-intestinal tract, which even may be the route of entry of the infecting stage of parasite. In this situation independent of helminth class involved the common symptoms and signs are loss of appetite, nausea, vomiting, pain abdomen, peptic-ulcer like syndrome, loose motion, nutritional deficiency. Sometimes, of course, there may be specific features dependent on type of parasite. To illustrate — pruritus ani (enterobiasis, strangyloidiasis, taeniasis), intestinal obstruction, vulus, perforation of gut, appendicitis (in ascarasis), anaemia (in hookworm infection), constipation with high eosinophil cells in stool (in chronic strongyloidiasis), protein-energy malnutrition (in fulminating strongyloidiasis, capillariasis and S. fuelleborni infection, heavy ascariasis, acute hookworm infection, H. nana infection), prolapse rectum (in heavy trichuriasis), passage of proglottids (in taerninasis), dysentery (heavy trichuriasis), Loeffler's syndrome or Ascaris pneumonitis (in hypersensitive subjects following subsequent exposure to *A. lumbricoides* infection). Wakana disease - a syndrome of acute onset of pharyngeal itching, cough, dyspnoea, urticaria, nausea, vomiting, wheezing, hyper-eosinophilia and infitsation visible on x-ray chest has been encountered in Japan following oral ingestion of faecally contaminated food. Ground itch on Cooley's itch in hookworm infection; Creeping erruption in non human type of hookworm infection (*A. braziliense, A. caninum* etc). Cysticarcosis (in *C. cellulose*) due to larval stage of *T. soluim*, which may invade various organs of body, eye, brain and spinal cord, heart, kidney, muscle, skin etc. Hydatid disease due to larval stage of *E. granalosus* - invading, liver, lung and other vital organs and multilocular cyst (larval stage of *E. multilocularis*) involving liver mainly. Hepatomegaly and jaundice commonly found

in *F. hepatica, C. sinensis, O. felineus, Paragonimus* spp. In *P. westermani* features of lung absces, bronchiactasis, blood sting sputum are common features. Varying degree of diarrhoea are commonly associated with *Echinostome* spp., *F. buski, Heterophyes* spp., Gastrodiscoides, *D. caninum, B. studeri, Hymenolepis* infection. WHO has made it mandatory to exclude *H. nana* and *S. stercoralis* infection in subject to be treated with steroides on other immunosuppressive drugs - as this therapy may precipitate disenirated strongyloidiasis and hymenolapiasis.

Infection with lymphatic dwelling filaria (*W. bancrofi, B. malayi, B. pahangi* etc.) presents a wide range of clinical features i.e., lymphaedema or elephantiasis of extremeties, genetalia, female breast, hydrocele/chylocele, epididym orchitis, chyluria etc. Tropical Pulmonary Eosinophilia (PTE) is very intriguing feature with non-human type of filarial infection and also in hypersensitive individuals. With *O. volvulus* infection in addition to various degree of subcutaneous swelling, blindness is a dreadful feature. Other features with *O. volvulus* infection are various types of darmatosis (acute pruritic rash, hypertrophic-hyper pigmented thickening of skin, lichenified - atrophic depigmented lesion. In addition to blindness other occular manifestations are punctate keratitis, secondary keratitis, iridocyclitis, choroidoretinal lesions and optic atrophy. In loiasis allergic manifestation in the form of urticarial rash, ANO, fever, conjunctional granuloma, painless oedema of eyelids are frequently encountered. The most spectacular finding is loiasis in subconjunctival migration of adult worms.

Guinea worm infection (due to *D. medinensis*) remains unsuspected until the adult females migrate to subcutlaneous level to produce a typical blister over skin. Following rupture of blister worms are found to potrude through the central hole in the ulcer bed. Till the safe method of extraction of the worm form the body by winding the protruded portin of the worm around a stick and subsequent gentle traction daily following larval ejaculation following sprinkeling of sterile cold water as was practired by Moses.

In trichinilosis (due to *T. spiralis* infection) nausia, vomiting and diarrhoea are encountered in the initial phase invasion of intestinal mucosa by excysted larvae; subsequently due to larval migration ejaculated from gravid females to muscles and deeper organs producing myopathy and invaded-organ-dependant clinical features like myocardial, cerebro-spinal signs and symptoms.

In bilharziasis due to *S. haematobium* infection haematuria is an unique clinical feature. Where as bowel disorder like diarrhaea is a common occurrence in *S. japonicum, S. mansoni* and *S. mekengi* infection. Massive hepato-splenomegaly is a frequent clinical finding with all types of schistosomiasis.

Visceral and cutaneous larva migrans are unique manifestation when incompatable nematode larva-human interaction occurs. As mentioned earlier following entry of infective larvae through skin host's cellular defence system does not allow further developmental progress of the larvae towards the adult stage as happens in compatable host system. There is a prolonged stay of larvae in the skin between stratum garminativum and stratum corneum. Abortive larval movement between these layers of skin before their death - producing the syndrome of cutaneous larva migrans (CLM)

or creeping eruption. In *S. strercoralis* infection the speed of this larval movement sometimes becomes very high - which is termed as larva-currence. The causative agents, commonly, are *A. brazilience, A. caninum* and less commonly by *Uncinaria stenocephalus, Bunostomum phlebotomum, S. stercolasis* (in hypersensitive host). There is infiltration of inflamatory immuno modulant cells, eosinophils, monocytes, macrophage cells, etc. around the larvae and ultimately causing larval death. Similarly following ingestion of non-human ascarial eggs containing infective larvae, hatched out larvae in man ofter entering the portal venous system migrate to liver, where host's cellular defence mechanism prevents further migration of larve (as occur in optimum host system). The inflamatory and cell mediated immune response in liver lead to hepatomegaly, fever, impaired oppetite, high eosinophil count in blood etc. producing the syndrome of visceral larva migrans (VLM). The parasites responsible for producing VLM are *Toxocara canis, T. Cati, Gnathostomes, Spirometra* sp., mesocercaria of *Alaria* and occasionally ancylostomes causing CLM.

Management of helminthic infection

The knowledge of helminth-man association, the resultant harmful impact on man and the process to "cure" man was since the early days of civilization. Various hosts used against worm-infection has been mentioned in ancient Hindu and Greek medicine.

Araca nut (seed of *Areca catechu* containing arecoline), pumpkin seed, coconut (*Cocos nucifesa*) — the flesh and milk, kousso or cusso (dried female flowers of *Hagina abyssinica*), Kamala (*Mallotus philippinensis* - having the active principles *kamalin*) has been used in India, China, Ethiopia against worms.

In Old Testament - hygienic measures to appreciate "unclean" meat (? goat infected with *F. hepatica*), "infected water" (? infected cyclops causing *D. medidensis*, ? cercaria of *Schestosomes*), method of extraction of guinea worm from man are well documented. In encient Egypt (1550 BC) infusion of the root bark of pomegranate tree (*Punica granatum*) was used against *Taenia saginata* infection. Theophrastus (300 BC) recommended fern root as an anthelmintic. Horodotuo (130 AD) used seed of Santonica or Levant wormseed against worm. Avicenna (980-1037 AD) the Percian physician on rational basis recorded the anthelmintics so far used by Greek and Roman physician.

There was a dark period of advancement of anthelmintics several centuries to come till late quarter of 19th century.

Terpenes - Santonin, Oil of Chenapodium (active principle Ascaridol), Thymol were in vogue to treat helminths since early Christian ara till first half of present century. Since the early period of the present century - Halogenated carbons - carbon tetrachloride (CCl_4), Tetrachlorethylene (C_2Cl_4) were used effectively against various intestinal nematodes and trematodes. Ethyl chloride was used for creeping eruption.

Monohydric phenols — Thhymol and Beta-naphthol (β-Hydroxynaphthalene) were used against hook worms and *F. buski* infection in first half of 20th century. Dihydric phenols - Hexyl-

resorcinol - a moderately broad spectrum anthelmintic has action against hookworms, *Ascaris, Enterobius, Taenias, Hymenolepis, F. buski, Gastrodiscoides* etc. But it is hepatotoxa.

Phenothiazine (phenylamines) - is active against - Enterobius and *D. medinensis* - but effective dose and toxicity are very close.

Medicinal Gentian violet (methylrosanilines) is effective against *Chlonorchis, Strongyloides, Enterobius, Hymenolepis,* but method of administration was hazardous. Mepacrine or Atebrin (Quinacrine) - a potent antimalarial, giardial also, found to be very effective against *Taeniasis* (*T. saginata* and *T. solium*) infection. Due to its toxic psychosis - institutional therapy under strict observation was advocated. This drug has now being withdrawn from market.

All the above mentioned drugs - being vermifuge — post treatment expulsion of worms did not show any morphological deformity, thus helped in recovery of the parasites. Further as most of the above mentioned drugs, being fairly toxic and comparatively less effective compaired with the recent drugs, are withdrawn from official lest.

Recent effective anthelmintics :

Bephenium hydroxynaphthoate (Alcopar) — a quaternary ammonium compound is non toxic and well tolerated, effective against hookworms (comperatively more effective against *A. duodenale* than *N. americanus*) and moderately effective against *A. lumbricoides*. Available powder in 5 gm sachet (containing 2.5 gm of base). From 3 yrs onwards the dose is same - 5 gm sachet at 12 hours interval - two such for asca riasis and three for hookworm infection. Being bitter in test masking with syrup is advocated. Mode of action-not clearly known.

Pyrantel (Pyranthel) — A cyclic amidines, white crystaline tasteless salt. It is a neuromuscular blocking agent, also inhibits choline esterase. Single daily dose of 10-20 mg/kg (maximum 1 gm) for 2-3 days. Very effective against *Ascaris, Enterobinus, Trichostrongylus* against hookworms — *A. dnodenale* is more susceptible compaired to *N. americanus*. Infants below one year of age and pregnant ladies it is not recommended.

Mebendazole (Mebex, Sandin etc) — A synthetic benzimidazole compound directly inhibits glucose uptake of worms leading to glucose depletion and decrease formation of ATP which is essential for survival and reproductive activity of parasites. Effective against *Ascaris, Enterobius* in dosage of 100 mg (tablet/syrup) twice daily for three consecutive days - following breakfast. Against hookworms and *Trichuris* - double the previously mentioned dose is essential.

Piperazine derivatives (Autepon) — The unsubstituted piperazine derivatives (citrate, adepate, phosphate, diphenylacetate) is very effective against *A. lumbricoides* and *E. vermicularis*. The drug produces neuromuscular block through an anticholinergic action at myonural junction in association with decreased succinate acid production by worms. In intestinal obstruction in ascariasis this is still the drug of choice. The drug is contraindicated in long standing renal and liver disease and recent jaundice. Dose - 75 mg/kg daily for 1-4 days in ascariasis and for 7 days in enterobiasis. Maximum daily dose should not exceed 4 gm.

Titramisole/Levamisole (Dacaris/Dewormis) — A white crystalline hydrochloride of 2,3,5,6-tetrahydro-6-phenylmidazole (2,6) thiazole. It inhibits succinate dehydrogenase activity of worms. It is also a potent immuno-stimulant. Effective against *Ascaris* and hookworms. Available in tablet form containing 50 mg and 150 mg base. Dose 2.5 mg - 5 mg/kg single dose for *Ascaris* and for hookworms for 2-3 days. Contraindicated in early pregnency and liver disease.

Thiabendazole (Mintezol) — A white crystalline compound 2,4(-thiazoyl)-benzimidazole. Available as tablet (500 mg) and suspension (500 mg/5 ml). Although exact mechanism of action is not clearly known it has been found to inhibit the enzyme fumerate reductase which is specific for helminths. Although very effective against Ascaris, hookworms, Enterobius, due to its untoward reactions (nausea/vomiting, headache, etc) it is now not recommended. But is used for CML and VMI and *S. stercoralis, T. spiralis.* Dose - 25 mg/kg twice daily for 3 consecutive days. Maximum single dose should not exceed 39 /day. In *Capillaria philippinensis* 25 mg/kg daily for 30 days. In CLM local application of 10% suspension over the affected skin areas 5/6 times/day until regression occurs. Thereafter three times daily over 2 weeks.

Albendazole (Zentil, ABZ etc) — A benzimidazole carbamate derivative acts by blocking glucose uptake both in larval and adult stages. The sulphoxide metabolate of the drug causes degenerative changes in the intestine of nematodes and tegumental cells of platyhelminths. It is poorly absorbed from the gastro-intestinal tract - the absorbed part being metabolized in liver is excreted in the urine as sulphoxide. Supplied as tablet (400 mg) and suspension 400 mg/5 ml. For *Ascaris* and *Enterobius* - single dose of 400 mg; in hookworm and *Trichuris* - 400 mg/day for 3-4 days; in Strongyloides 800 mg/day - 4 days. In echinococcosis - 10-15 mg/kg/day (in three divided dose) for 30 days 4 such course - separated treatment free period for 15 days. In neurocysticercosis - 15 mg/kg/day for 30 days.

Niclosamide (Yomesan, Niclosan) — Available in the form of chewable tablet (500 mg). Effective against intestinal cestodes. 2 gm single dose is effective in *Taenias, H. diminuta, D. latum, D. caninum* etc. In *H. nana* - 7 day therapy is needed. Day one - 2 gm and for next six days daily dose of 1 gm. The drug is not effective in larval forms of cestodes.

The drug acts by blocking oxidative phosphorylation in mitochondria, causing release of parasite from intestinal mucosa.

Praziquantel (Cysticide) — A synthetic pyrizine derivate. It is slightly soluble in water and about 50% is rapidly absorbed after oral administration. The drug passes the blood brain barrier (14-20% of drug plasma concentration). It is excreated primarily as metabolite through the kidneys within 24 hours.

It kills both larval and adult stages of worms. The adult cestodes rapidly contract and disintigrate in the intestine. Most larvae are killed even when encysted and disintigrate completely within 5 months. All doses are suitable for adults and children over 4 years. Dose:

Intestinal taeneasis 5-10 mg/kg, hymenolepiasis 15-20 mg/kg; diphyllobothriasis 10-25 mg/kg - all single dose. In cysticercosis 50 mg/kg daily in three divided doses for 14 days. A corticosteroids - such as prednisolone should be administered for 2-3 days before hand and along the entire period of treatment. In dermal cysticercosis - 60 mg/kg daily in three divided doses for 6 days. In schistoromiasis - single dose of 40-60 mg/kg. In clonorchiasis and opisthorchiasis 25 mg/kg three times for one day. In paragonimiasis 25 mg/kg three times daily for 2-3 days.

Metrofonate — An organo phosphorus compound. Its metabolic product dichlorvos, a highly active anticholinesterase, has the anthelmintic property. It is used in *S. haematobium* in the dose of 7.5 to 10 mg/kg on three occasions at interval of 2 weeks cures about 40-50% of cases. Even when viable worm remains egg count after one year are reduced to less than 20% pre-treatment levels. The drug is available as 100 mg tablets.

Oxamniquine — A tetrahydroquinoline derivative with selective action against *S. mansoni.* Male *Schistosomes* are more susceptible than females, but the residual female worms cease to lay eggs after exposed and lose pathological potentials. Dose has a geographical variations. In West Africa, South America, Caribbean island - single dose of 15 mg/kg; East and Central Africa and Arebian peninsula - 30 mg/kg in two divided dose; Egypt, Southern Africa, Zimbabwe - 60 mg administered over 2-3 days. Maximum single dose should not exceed 20 mg/kg. Mechanism of the drug action is not known.

Diethylcarbamazine - DEC (Hetrazan, Banocide) — DEC is a piperazine derivative, kills microfilaria (mf) and to some extent action on adult worms. It has no action on III and IV larval stages of *W. bancrofti*, but has prophylactic action on *B.malayi* in cat and presbytis monkey. Although *in vitro* studies revealed no significant action of DEC, *in vivo* it causes rapid disappearence of mf from the circulation, perhaps due to sensitization of mf to be trapped by the RE system. Acute clinical manifestations remains unaffected. Epidemiologic studies have indicated prevalence and incidance of lymphangitis. Treatment of mf carrier with DEC reduce the incidence of chronic disease. Sometimes early reversible oedema may be favourably affected by treatment. But huge hydrocele and elephantiasis with deformities remain unaffected. In occult filariasis — TPE and M-K syndrome marked clinical and haematological improvement occur. Dose : In *W. bancrofti* infection a total cumulative dose of 72 to 84 mg/kg for 12-14 days in divided doses after meals. In *B. malayi* and *B. temori* - 3-6 mg/kg/day for 10-12 days in divided doses. In children under 10 years of age should receive half the total adult dose. The drug should be given orally.

In Mass treatment - 3 to 6 mg/kg in 24 hours in three orally divided doses at weekly or monthly interval are in use in many countries. In India and China - medicated table salt with 0.1% DEC daily for a period of over 6 months is very promising for mf control. In *B. malayi* endemic areas a concentration of 0.3% for 3 to 4 months may be necessary.

In occult filariasis (T.P.E and M-K syndrome) - 8-12 mg/kg daily for 14 days is effective. This is to be repeated if symptoms re-appears. In many countries various dose schedule are under trial but final unequivocal dose-schedule is yet to be obtained.

Contra-indication and precaution : In renal impairment the dose should be sreduced. In severely ill patients treatment with DEC should be deffered till their recovery. In pregnency treatment should be with held.

Side effects — Immunological disturbance with Mazzotti reaction in Onchosercosis are indued by disintrigration of mf and dead adult worms. Mf density in blood and dose of DEC has a direct relation to produce reaction. Weakness, dizzyness, lethergy, sleeplessness, anorexia, nausea, vomiting, fever, generalised body rash may appear within 2-3 days of treatment. Antipyretics, analgesics may be helpful. Steroids, if not contraindicated may be very useful. Local reactions, e.g. lymphadenitis, lymphangitis, abscess formation, ulceration and transient lymphoedema etc. may occur with decreasing frequency in that order or in varying combination may be encountered. The precipitation of this local reactions has adverse effect on filaria control programme.

Ivermectin — A semisynthetic derivative of avemectin a fermentative product from the broth of soil actinomycete *Streptomyces avermitilis*. By relative catalytic hydrogenation of avermictin β_1-invermectin (80% component β_{1a} and 20% component β_{1b}) is produced. Its activity is due to immobilization of parasite by producing a toxic paralysis of peripheral musculature by potentiation of release of and binding of GABA (gama amino butyric acid) at certain synapes. It paralyses nematodes and arthropods by disrupting GABA mediated transmission of signals in peripheral nerves. GABA is a neuro transmitter for both vertebrates and invertebrates. It is well absorbed and plasma half life is 12 hours. It is excreted in the faeces over a period of 2 weeks.

Uses — In *O. volvulus* a rapid and marked decrease in number of mf count of skin and occular tissues lasting for 5-6 months. It has no action on infective and immature larval stage or adults worms. In *W. bancrofti* and *B. malayi* - it has shown some action against microfilaria. On intestinal nematodes e.g. *S. stercoralis, A. lumbricoidess, T. trichiura, E. vermicularis* the drug is effective.

Dosage — Single oral dose of 150 mg - 200 mg/kg of body weight is for adult and children over 5 years of age. No food should be taken for atleast 2 hours before and after ingestion of the drug. Drug should not be used in pregnency. Mother should not breast feed during treatment.

Side effect — The drug is generally well tolerated. Mild occular irritation and transient non-specific ECG changes may occurs. Mazzotti's reaction is rarely severe. Transient postural hypotension, headache, nausea/vomiting, pruritus, rash, myalgia, arthralgia, lymphadenitis, lymphadenopathy, oedema, fever, weakness, tachycardia, conjunctivitis and diarrhoea have

been recorded.

Over dosage - may cause mydriasis, somnolence, depressed motor activity, tremor and ataxia. Emesis, gastric lavage and symptomatic treatment are of value when undertaken within a few hours of ingestion.

Selected References

Banerjee, D.N. (1941). "Antiquity of Hindu and Greek Medicine". The Medical Busreau, Calcutta.

Warren, K.S. (1988). The Evolution of Parasitology in "Parasitic Infections". (J.H. Leech, M.A. Sande, R.K. Root Eds) pp. 1-10. Churchill Livingstone, New York, Edinburgh, London, Melbourne.

Chatterjee, K.D. (1952). "Human Parasites and parasitic Diseases", Calcutta, India.

Beaver, P.C., Jung, R.C. and Cupp, E.N. (1984). "Clinical Parasitology". Lea and Febigar. Philadelpia.

Gustafsson, L.L., Beerman, B. and Abdi, Y.A. (1987). "Hand Book of Drugs for Tropical Parasitic Infections" Taylor and Francis. London, New York and Philadelphia.

□

ARTHROPODS AND OUR SKIN AFFLICTIONS

S.K. Dasgupta

Former Professor, Department of Zoology,

Presidency College, Calcutta - 700 073

Arthropods, the invertebrates with regionated body bearing jointed appendages, affect us in many ways one of which consists of the mass of afflictions they cause in our skin through touch- or bite contact. We are more aware of the disease pathogens they transmit in us and their role as carriers or vectors of malarial, filarial or other pathogens but we do not know much about the harms they do to our body's first line of defence — the skin Since arthropods of diverse forms, separate names and identities, habits and habitats are involved and the skin mutilations they do assume from small and simple to bizzare manifestations alongwith various systemic effects, it is pertinent that we discuss and delve into all these aspects and as Zoologists disseminate and create knowledge relating to them for individual and social welfare.

A. Insectan Arthropods :

(a) Hemipteran afflictions -

Bugs of some 12 families by their piercing-sucking mouthparts may bit us often imbibing blood that they need as their natural food. Bedbugs (*Cimex*) and Reduviid bugs (*Triatoma*, commonly called Kissing-/Assasin bugs) are notorious in this respect, the latter for inflicting extremely painful bites. Species of Belastomidae, Cercopidae, Cicadellidae, Lygidae, Membracidae, Miridae and Nabidae are also notorious biters causing pain, urticaria and blisters in our skin. The toxin factor lies int he insects' saliva full of highly active proteolytic enzymes together with hyaluronidase and other enzymes. All bugs defeacate after feeding and this contaminates the skin-injury they cause in us.

(b) Lepidopteran afflictions -

These may set in either of the following ways : i) due to reaction by "dusts" off dry- preserved moths and butterflies kept in closed boxes, the "dust" being the crumbled and dehisced surface materials of the insects that "volatile" out of the boxes on *abrupt* opening of their lids and fall on our skin or may be inhaled byus; Ii) due to reaction from contact and penetration of our skin by poison hairs/spines, usually of the insects' hairy caterpillars (even upto 20 lacs of such spines per caterpillar), such processes being broadly grouped into 3 types — short and conical processes with rows of stinging setae, multiple long and strong spines from a conical eminence, and multiple spines with terminal plugs. Subtypes of these add to their structural and functional diversities, one important subtype being anal tufts of spines of adults in some species. Awareness of the ways of the skin and other distresses due to 'Caterpiller Contact' is surprisingly low — stinging spines off the crawling caterpillars or flying adults or off the dry, dead ones lurk in our clothing, edible fruits and vegetables or may be blown off to our person.

Out of about 2 lac Lepidoptera species, some 150 species — mostly the moths of *Derpha, Hylesia, Lymantria* and *Tryporyza* and butterflies of families Limacodidae, Megalopydiidae, Morphidae and Nymphalidae carry such mischievous spines. Histamines and Adenyl Compounds variously combine to form the toxic factor in Caterpillar-Contact.

(c) Dipteran afflictions -

Cutaneous myiasis by fly maggots is very important. Variety of flies that habitually breed in carrion or decomposing animal and vegetable material are the insects concerned and those belong to any of such dipteran groups as — Calliphorid or Bluebottle Flygroup (Old World Screw worm fly *Chrysomia bezziana*), Greenbottle Flygroup (*Lucilia*), Muscid Flygroup (*Musca domestica*) and Sarcophagid Flygroup (*Sarcophaga*). These flies lay eggs on damaged skin (any discharging wound or encrustated/scaly area of skin or eczematised skin) and the resulting carnivorous maggots grow through skin mutilation and tissue destruction.

Other types of skin mutilations in us are caused by adult stages, mostly females, of blackflies, biting midges, mosquitoes, sandflies and TseTse flies of the Nematoceran Diptera and of such other flygroups as deerflies (*Chrysops*), horseflies (*Tabanus*), stableflies (*Stomoxys*) and deer- and sheep keds (*Hippobosca*). These are haematophagous and feed on us freely puncturing and mutilating our skin through release of toxin during feeding.

(d) Coleopteran afflictions -

Beetles whose body fluids have blistering properties cause widespread, painful skin eruptions in us. Three principal groups involved are : (i) Staphylinidae beetles commonly called 'Spider-Lick beetles/Cocktail beetles/Rove beetles which impart 'burnt' marks in the skin of our facial and neck region by the toxin factor 'Paedirin' (a kind of Cantharidin) of their body fluid that may come out of the insects on their crushing or the insects spreading them by pouring saliva; (ii) Meloidae beetles commonly called Oil beetles/Soldier beetles are the true blister beetles as these cause watery boils in the affected parts of our body specially the backside and our skin liberally ulcerates through eruption of boils. Fresh boils develop at spots touched by cozing fluid. The Spanish fly *Lytta* leads the show. One easy way to escape from such fluids is to gently drive out any roaming blister beetle just by mild blowing; (iii) Bombardier beetles form a special group of blister beetles in that they throw their toxic body fluid in a jet-stream on victim in front by curving their abdominal tip.

Larvae of some Carpet/Furniture beetles (Dermestidae) have urticating hairs that cause dermatitis. If crushed, their toxic body fluid causes alsoblisters. Some of them may emit the fluid if irritated.

(e) Hymenopteran afflictions -

Bees, hornets and wasps, and the ants variably attack us by their stings which are modified ovipositors (simple needle-like structure with side-serations in some cases) occasionally so thick and stout as to cause enough skin mutilations in us. A bee worker has the vicious habit of 'discharging' its sting in our person while a fireant worker (*Solenopsis*) grips at first our skin by its tiny mandibles and then rotates its sting-bearing abdominal tip inflicting the sting serially so as the cause painful papulae in a ring in our skin. Carnivorous ants bear powerful stings while vegetarian ants have vestigial stings. The latter ones however compensate the deficiency by lacerating our skin with their mandibles and atrophied sting and then discharge formic acid on the lacerated part to make the area more painful.

(f) Afflictions by other insects -

(i) Lice (Anoplura) affecting us are : Body lice (*Pediculus corporis*) and Head lice (*P. capitis*) inhabiting respectively our general body parts and head cause 'lousiness' (Vagabond's disease) in us when the affected skin areas show stains and haris there form entangled masses with fungus

affecction in unwashed cases. The Public lice (*Phthirus pubis*) lodged within hairs of genital region cause similar symptoms (Phthiriasis). Itching is constant in both cases, and neflect leads to cutaneous lesions. Flea bites are quite common in warm weather and these cause papular urticaria with itching, scratching etc., that lead to skin lesions. A disorder in man called Tungiasis is caused by the flea-species Tunga penetrans; skin lesions by it are more vicious and a few such at plantar aspect of our toes may make walking on foot or even mere standing difficult for us.

(ii) The ubiquitous nuisance-insect the Roaches (Dictyoptera) are also able to inflict on us contact reactions and bite damages. Apart from their ability to cause significant systemic distresses in us (ingestant allergins passed to us through roach-infested food or inhalant roach antigens overpowering us on mere opening up of a roach-loaded drawer), urticarial reactions in our skin set in while handling roaches or stamping them while wearing roach-infested shoes due to roach secretion having toxic factors of trans-2-hexenal and aldehydes, quinones and other chemicals. Roaches gnaw toe- and finger nails and calloused skin of sleeping persons.

(iii) The fringe-winged insects Thrips (Thysanoptera) though very small in size can in large numbers cause skin mutilations and inconvenience to us. Then those may be quite annoying by getting into our nostrils, auditory canals or conjunctival sacs. Countless pinkish dots in our skin with itching and prickling sensation follow from thrips bites and some thrips species may cause erythematous macules and popules (3 mm diameter) followed by eruptions and lesions.

B. Non-Insectan Arthropods

(a) Centipede bites and Millipede burns -

First pair of trunk appendages, the maxillipedes or the toxognaths, of a centipede like *Scolopendra* have powerful claws with venom glands. 'Bite' by such poison claws causes immediate feeling of heat and tingling followed by severe pain. Two haemorrhagic points develop sequentially. The venom which is clear in some and opalescent in others contains mainly digestive enzymes.

The Millipede burns in our skin transform into Millipede lesions due to contamination of the injury by a toxic fluid of Julus, Spirobolus and other Millipedes. Skin becomes yellowish and blisters may also develop. Toxic fluid contains p-benzoquin other quinones/p-cresol/benzaldehyde/ hydrocyanic acid.

(b) Scorpion stings and Spider bites -

Scorpion stings cause serious local effects leading even to death through systemic failures in immature or weak victims. Widespread swelling with intense pain and internal/external allergic symptoms followed by severe systemic distresses occurs in no time. The venom contains several types of proteins and other toxins that act as neurotoxins with adrenergic and cholinergic effects.

Spider bites cause more of systemic distresses and death from bites of Blackwidow spiders (*Latrodectus*), Funnel-web spiders (*Atrax*) and *Loxosceles* spiders is not uncommon. Theraphosid

spiders are large and hairy having urticating hairs. Spiders produce 3 types of venomous toxin - Neurotoxin (*Atrax* and *Latrodectus*), Cytotoxin (*Loxosceles* and *Lycosa*) and haemolytic toxin (*Loxosceles*). Gangrenous lesions in skin may result from spider bites.

(c) Bites of Ticks and Mites -

Ticks are large-sized Acarina and stick to our person to feed on us. Their bites mutilate our skin causing itching, nodular lesons and bullous eruptions plus Tick-bite Alopocia and hair loss together with systemic distresses such as Tick Paralysis, ECM and Lyme diseases. Bites of *Ornithodorus* Ticks are painful. Tick toxin comes from saliva and its nature is still unknown.

Amongst mites, the Itch mite *Sarcoptes scabiei* burrows in our skin which degrades into pastulate/bulbous lesions emitting mousey odour if unattended and these afflictions form 'Scabies' in us, Paraketosis of toenails and Norwegian Scabies being two extremes of such cutaneous disorders.

'Copra itch' and 'Grocers itch' are similar to Scabies and are caused by mites infesting stored food, cheese, dried fruits and other organic materials while 'Green itch' which is a state of 'lousiness' amongst bakers, corn-grinders and millers is caused by Pyemotes mites / Hair-Follicle mites (*Demodex*). The Gamasid mites, patent vectors of rickettsial and viral bodies, cause similar irritating skin-eruptions in us for which another mite-group the Chheyletiellid mites inhabiting domestic pets may also be responsible.

Of considerable interest are the 'invisible' dust mites which may cause serious allergic reactions in our skin besides asthma, hayfever and other systemic diseases. Mite caused afflictions in our skin are mostly due to plain physical mechanism together with secondary infection by Streptococci and formation of antibody in allergy-related cases.

C. Concluding Remarks

Because of the active and widespread nature of arthropods, the damages they do to us at individual or mass level as discussed above cannot be insignificant. Awareness of those damages and their perpetrators, about preventive and curative aspects can go a long way in combating the menace. More serious is the delusion of Cutaneous parasitois due to arthropod contact/bite/ infestation complained of by "patients" now and then in absence of any real evidence to substantiate their complaints. Once taken over by the Entomophobiac Syndrome, the same does not leave a person easily and as a committed "patient" he merely goes on changing physician for elusive cure!

The need of awareness is thus crucial.

Selected References

Alexander J. O'Donel (1984). Arthropods and Human Skin. Springer-Verlag, New York.

Gillot, C. (1995). Entomology. Plenum Press, New York.

Rohinson, W.H. (1995). Urban Entomology Insect and Mite pests in human environment. Chapman & Hall.

Roy, D.N. and Brown, A.W.A. (1954). Entomology (Medical & Veterinary) including insecticides & insects & rat control. Excelsior Press, Calcutta.

□

BIOLOGY AND BEHAVIOUR OF MALARIA PARASITES

T.N. Ghosh

Professor of Protozoology (Retd.)

Calcutta School of Tropical Medicine

P.O. Box - 12380, Calcutta - 700 073

Introduction

The number of recorded species of malaria parasites, described from mammals, birds and reptiles is 171, so far. They comprise 48 species from mammals, 52 species from birds and 71 species from reptiles. Four species of the genus *Plasmodium* usually infect man and are able to cause a disease condition called **"malaria"**. This word has been derived from the Italian word for bad air not directly related to the infection, yet commonly used for this condition. Scientifically the term **"plasmodiosis"** appears more appropriate and has never been used widely.

Distribution

Endemic areas are those where transmission of malaria occurs with new cases appearing over a number of years. Indigenous malaria transmission demands an average ambient temperature exceeding 15 degrees Celsius for at least one month in the year. Malaria has been reported as far north as 60 degrees N latitude (Archengel in former USSR) and as far south as 32 degrees S latitude (Cordoba in Argentina). It has been reported from the Dead Sea area at 400 m below the sea level and at 2,000 m above the sea level, Londiani (Kenya) or at 2,800 m in Cochabamba (Bolivia).

Importance of malaria

About 2 billion i.e. half of the total population of our planet is exposed to malaria. Of these 4 million people get infected with malaria. It is estimated that 100-200 million new cases of malaria

per year are reported. One to 2 million people dies per year and most of them are infants and children in Africa, being infected with *P. falciparum.*

Malaria in human history

a) Probably malaria parasite is older than man is.

b) Experts indicate that human *Plasmodium* may have been evolved with man in Africa. *Falciparum* malaria may be an exception, adapting itself to man relatively recently. With human migration, malaria migrated in Neolithic period into Europe, the Middle East, Asia, India and China. Its spread to Central and South America was probably from Asia in pre-Columbian times, perhaps in the first millennium AD.

History of malaria studies

a) *Atharva Veda* [2000 BC]

Vedic medical teachings refer to autumnal fevers, rhythmical fevers — one every other day (tertian). On both days (quotidian) and on third day (tertian) and system of temperature reduction by hot water sponging.

The demonic cause of febrile illness was *Takman*, the divinity itself. In the form of thunder and lightning, which accompanied the monsoon rains, brings about the illness characterized by intermittent and recurring fevers along with other symptoms.

b) *Susruta* [500 BC]

Descriptions of twelve lethal fevers, including acute fevers, and the mosquitoes, causing them are available.

Some milestones in the history of malaria [1880-1998]

a)	1847	Dempster in India introduced spleen palpation of children as an index of epidemicity of malaria.
b)	1880	Laveran in Algeria discovered and described malaria parasites in human blood.
c)	1897	Ross in India discovered pigmented cysts (oocysts) on the stomach wall of an Anopheles mosquito (probably *A. stephensi*)
d)	1936-39	Discovery of insecticidal action of DDT (synthesized by Zeidler in Germany 1874) by Muller and Wiesman in Switzerland.
e)	1948	Shortt, Garnham, Covel and Shute described pre-erythrocytic forms of *P. vivax* in the human liver.
f)	1980	Discovery of **hypnozoites** in the life cycle of some malaria parasites.
g)	1987	Recombinant DNA *P. falciparum* vaccine and synthetic peptide sporozoite vaccine both tested in human volunteers.
h)	1992	Field trials of asexual stage vaccine and of sporozoite vaccine.

The systematics, life-cycle, chronobiology and behaviour

The systematic position of the genus *Plasmodium* is as the following : Phylum - Apicomplexa; Class - Aconoidasida; Order - Haemospororida; Family - Plasmodiidae, Genus - *Plasmodium*. The four species of human malaria parasites are *P. vivax* (P.v.), *P. falciparum* (P.f), *P. ovale* (P.o) and *P. malariae* (P.m).

The sequence of events in the life cycle of human malaria parasites is given below. A malaria parasite (mature sporozoite) has to penetrate two types of liver cells, i.e. the Kuffer cells and the hepatocytes, each in proper sequence and again, perhaps several times the appropriate RBC in the human host. The ability to penetrate the RBC and to complete the erythrocytic cycling exhibit many predetermined factors e.g. the point of time of entering the RBC, the choice of its type, age group, type of hemoglobin content, nature of the surface coat etc. The duration of the period of residence within the chosen RBC corresponds with the duration of *one* diurnal cycle of our planet (i.e. 24 hrs. for *P. knowlesi*, a monkey malaria parasite; 48 hrs. for *P. vivax* and *P. falciparum*; and 72 hrs for *P. malariae*) or it's multiple. The end of erythrocytic cycling of the malaria parasite is the beginning of the morbidity, which may lead to mortality, in some cases. During the sporogony cycle, within the appropriate female anopheline mosquito, the ookinete, a post-zygotic kinetic (motile) form of the malaria parasite has to penetrate the single cell layer of the mosquito gut wall to enter the haemocoelomic space, in order to produce oocysts and then the sporozoites. Thus the entire cycle of sporozoite to sporozoite formation completes. The stages are given in the following sequence.

I. *Exo-erythrocytic (e-e) schizogony*

Sporozoite to Hypnozoite (in some malaria parasites - *P.v. P.o*) to Schizont to Merozoite.

II. *Erythrocytic (e) phase*

Trophozoite to Schizont to Merozoite, Gametocytes, both female and male.

III. *Mosquito (sporogony) phase*

Gametogenesis, production of both female and male gametes, fertilization, Zygote formation, to Ookinete formation, then Sporozoite formation and maturation.

IV. *Profile of the life cycles of human malaria parasites*

Characters	*P.f*	*P.v*	*P.o*	*P.m*
I. e-e phase				
Minimal time of Development (in days)	5.5	8	9	13-16
Merozoites per schizont (in thousands)	40	10	15	2
Hypnozoites	Not yet demonstrated	Yes	Yes	Not yet demonstrated
II. e-phase				
Period of cycling (in diurnal cycle period i.e. 24 hrs.)	2	2	2 +	3
Merozoites per schizont	8-16	16	8	8-10
"Withdrawal" of segmenting forms	Yes	No	No	No
Parasitemia per millimeter cube of blood (in thousand)	Extremely variable, 500, may rise to 30-40%	5-20 may rise to 60	<10 may rise to 100	<10 may rise to 25-50, rarely

Some human genetic factors in malaria infection

Intracellular parasitism exhibits extreme biological interactions, between cells with widely different types of genomes. Human erythrocyte and malaria parasite appears to be a good example of such interaction, operable at the sequential stages of a) selection, b) invasion, c) intra-erythrocytic development, and d) liberation of merozoite. Therefore, genetically controlled characters of the host cell RBC are likely to influence the life cycles of the malaria parasite. This may occur in the components of the surface coat of the RBC or in the intracellular components and their metabolic pathway. It is also important to consider that erythrocytes possessing genetic alterations, showing apparent normalcy may interact vigorously when parasitised by the malaria parasites.

Some genetic abnormalities of human erythrocytes have been found to decrease their susceptibility to malaria parasites. Recently a limited number of susceptibility genes have been identified. Evidences are gaining ground that the specific receptors of Duffy blood group antigens onthe surface coat of the erythrocytes are required for the invasion of *P. vivax* merozoites. Whereas in the case of *P. falciparum* infection, the sialoglycoproteins, glycophorin A and B are likely to be involved.

Haemoglobin is the major intra-erythrocytic component. Evidences are available that HbS mutation confers a protective value in *P. falciparum* infection probably because a) deoxy-HbS aggregates within the RBC interfering with the intra-erythrocytic schizogony or b) initiating sickling

of the RBC with developing schizont and subsequent removal by the macrophages.

Glucose-6-phosphate dehydrogenase (G6PD), among other intra-erythrocytic components deserves special mention because female heterozygous of this X chromosome-linked gene are genetic mosaics and its deficiency has been found to show relative insusceptibility to *P. falciparum*. Cultivation *in vitro* of this parasite has been offering excellent opportunity to explore this mechanism.

The other red cell genetic disorders implying protection against malaria are HbC, HbE, HbF, the thalassaemias, spherocytosis and ovalocytosis.

Other genetic host factors, in man-malaria interactions, appear important because the sporozoites and merozoites are exposed to intimate contact with liver cells and serum proteins, however for short periods. Therefore, genetic variations of tissue factors and serum proteins are likely to influence the interaction.

Aspects of control measures and their implementation

Breaking the vicious cycle of man malaria and mosquito is of paramount importance. This is achievable with the concerted and continued efforts of all concerned, using the available tools to combat malaria. Success story of the community participation via co-operative movement by the then Anti-Malaria Society (1910-1946) in undivided Bengal is available. This movement inspired Rabindra Nath Tagore who with L.K. Elmhirst, Harry G. Timbres, Gopal Chatterjee and others used this co-operative method in his rural re-construction efforts. The time has changed. Now it is difficult to motivate the community, both rural and urban. The hopes are still there in the really benevolent NGOs who may motivate the community participation in a sustainable manner with proper awareness of malaria. Above all, the decision-makers must have the right will, and therefore, provide the resources in a congenial condition; then only, malaria control will not more remain a dream.

Selected References

Garnham, P.C.C. (1966). Malaria Parasites and other Haemosporidia. Pp xviii+1114, Blackwell Scientific Publications, Oxford.

Knell, A.J. (Editor) (1991). Malaria, pp vi+87. Oxford University Press, Oxford.

Kreier, J.P. (Editor) (1980). Malaria, Vol. I pp xvii+416; Vol. II. Pp xvii+328 and Vol. III, pp xvii+346 Academic Press, New York, London.

Levine, N.D. (1988). The Protozoan Phylum Apicomplexa. Vol. I pp xii+203; and Vol. II, pp xii+154, CRC Press, Boca Raton, Florida, USA.

Peters, W. (1998). Drug resistance in Malaria Parasites. *Advances in Parasitology* **41**, 1-62.

Phillips, R.S. (1983). Malaria, pp iv+58, Arnold-Heinemann, London [First Indian Edition 1984 published by Gulab Vazirani, New Delhi].

Warrell, D.A. (Editor) (1998). Tropical Medicine, achievements and prospects. *British Medical Bulletin*

54(2) : 265-520.

Wernsdorfer, W.H. and McGregor, Sir Ian (Editors) (1988). Malaria, Principles and Practice of Malariology. Vol. I, pp xvi+912+A38+S70 Vol. II pp xvi+913-1818+A38+S70 and I. Churchill Livingstone, Edinburgh, London etc.

□

TOPOLOGY OF EVOLUTIONARY STRUCTURE AND *URGLEICHUNG*

K.K. Misra

Department of Zoology,

Rishi Bankim Chandra College, Naihati 743 165, North 24 Paraganas

Life when considered as a process, can best be explained through evolution. In biology, any process, is thus referred to as the result of the evolutionary consequences. All biological processes, including evolution is expected to have definite topological structure. It is presumed that all biological phenomena should follow a common topological pattern and a relationship should exist among all the biological activities, including reproduction, heredity, evolution, etc. Physicists are now debating on reversible and irreversible universe. Irreversibility is an inherent property of a biological system. Evolution of the life process involves an irreversible progress and it always generates continual new information. New information accumulates as time passes. Each step of evolution is unstable in relation to time. The evolutionary step display time-dependent discrete variations. Thus, the biological species, as well as functions, arise as a result of the instability of the preceding form. So evolutionary process always exhibits forward progression and is irreversible.

There has to be a common unitary mechanism that would govern or maintain all the biological activities. This mechanism is expected to follow a structural model. Whatever may be the variation in the form and fucntion of the biological system, this unitary mechanism would always reflect the basic topological/structural pattern. That is topology provides universality of a given structure that regulates a function. This is also true in the non-living world. Ilya Prigogine also emphasised the idea of irreversibiliy and arrow of time. The reason being that in spite of innumerable variations in structure and function, there is a common principle around which all variations rotate. This ensures the continuity of the process and maintains the mechanism. Thus there is no breakdown or a sudden halt in the life process. Variations in structure and function which are apparent develop due to their weak interactions with the fundamental structure. Handedness or chirality in molecules

had been established by Louis Pasteur with a comment that the Universe is dissymmetric at all levels, from the subatomic to the macroscopic. Hegstrom and Kondepudi (1990) in an excellent review made it clear that most objects that are found in nature possess chirality. Topological stability is related with the chiral nature of the biological molecules. The chiral nature in biology can be seen in L-amino acids and D-sugars which are the enantiomeric series dominating the biochemistry of living organisms. Most of the biological expressions or manifestations are circular in nature. In biology we, thus, use the term 'cycle' with reference to reproduction, physiological regulation, beavioural pattern, inheritance process, etc. All the progressive circular movements are helical in nature i.e. their topological structure is a helix. Thus, the fundamental properties for all living matter is helical in nature because of their two important characteristic features viz., instability and irreversibility. The helix may be either right-handed or left-handed. In other words, all circular movements when considered against time appear as helix, i.e. time proves extra-dimension to an existing plane resulting in a three-dimensional configuration. Cyclical phenomena in biology are governed by the inherent variable rotational energy. This develop into a helix due to interaction with the environmental forces. Asymmetry and/or apparent symmetry is the result of the rotational property which is inherent of any system. Pier Luigi Luisi (1993) argued about 'circular logic' in autopoiesis and evolution. He explained that if a modification of structure is allowed in a self-generation process (i.e. simultaneous replication and mutation) 'we go from cyclic to a helical pattern, i.e. we have replication but with a movement in the time axis'.

All the ecological phenomena rotate in a circular manner. Biological or physiological rhythms exhibit rotational property. Biogeochemical cycle can be considered as a good example in this regard. All these cyclical phenomena are guided by the inherent variable rotational energy and developed into a helix due to interaction with the environmental forces. Asymmetry and/or apparent symmetry is the result of the rotational property which is inherent of any system. The rotational asymmetry as well as symmetry are achieved through individual rotational energy which is variable. Reggia *et al.* (1993) argued that in computational cellular automata model of self-replicating structures, variable rotational symmetry is present instead of strong rotational symmetry as thought earlier.

The topology of the helix in biological systems resembles that of an RNA molecule. This simple helical form of RNA, on the other hand, is similar to the fundamental particle neutrino. In this context, it may be said that DNA, though exhibits a helical form, is not the fundamental molecule of the living world because the present day DNA must have attained a double helical form from a single strand ancestor. It is well known fact that RNA is a single helix and can perform all the basic functions of life (Misra, 1992). On this basis, 'RNA World' concept of origin of life is favoured.

According to Brooks and Wiley (1986) biological evolution is a time-dependent or irreversible process. They suggested that the theoretical frame-work for biological evolution is based on four principles : (a) the principle of irreversibility, (b) the principle of individuality, (c) the principle of

intrinsic constraints and (d) the principle of compensatory changes. These four principles can be well explained within the proposed topological structure of properties of evolutionary process. The first principle is comparable to instability of the past i.e. time-dependent stability, the result of which is the fourth principle. The third principle may be comparable to the inherent rotational energy which is variable in relation to time, form and function of the system concerned. This leads to the second principle which is nothing but the variation in form and function that interacts weakly to the fundamental structure.

In one of his articles Walter Thirring of Institute of Theoretical Physics, University of Wien put a question that 'do the laws of Nature evolve?' Thirring believes that 'the time evolution dictated by the *Urgleichung* (Theory of Everything) contains the dynamics of the whole universe and determines everything'. He stated that laws of nature has evolved together with the evolution of the Universe. This also clearly points towards irreversibility. Thirring maintained that, 'As the universe evolved, the circumstances created their own laws. In this sense the laws which appear fundamental to us not have existed in the beginning as laws but only as possibilities' (Thirring, 1995).

At present we live in a world with three space dimensions and one time dimension is the basis of our theories. At the same time many people would wonder how strange life would be in worlds with more dimensions. The current way of thinking suggests that 'at the beginning the world had far more dimensions and by some anisotropy only three dimensions have expanded enormously' (Chodos and Detweiler, 1980). By now the others have collapsed and left their traces in internal symmetries of elementary particles. The splitting in 4+ x dimensions might have appeared accidentally and is unpredictable. Such an unpredictability seems to contradict the deterministic time evolution. Thus the Theory of Everything (*Urgleichung*) must potentially contain all possible routes which the universe could have been taking and therefore all possible laws.

Origin of chirality in molecules has not yet been solved but biomolecular chirality develops due to the inherent handedness of the weak force. However, chirality in molecules, as Pierre Curie has envisaged, is based on two forces i.e. 'axial' with a rotational form and 'polar' with a vectorial translatory form. The collinear combination of forces results in helical motion of chiral molecules. The similarities between molecules and the living world is that both exhibit chiral nature, and chirality is the result of irreversibility. Topology of evolutionary structure, thus, originates from basic chiral nature of the molecule and reflects in every form and function of the biological world and is amplified through evolutionary phenomenon. As a result the three dimensional topology in biological systems can be visualised with the help of time as the third dimension. Thus it can be said that the properties of evolutionary structure is helical in nature. Interestingly, the basic molecular form in biology, RNA, exhibits similar topology. From this angle, it can be concluded that simple helical topological form is fundamental to all biological system and function and it presumably stems from RNA.

Selected References

Brooks, D.R. and Wiley, E.O. (1986). *Evolution as Entropy : Towards a Unified Theory of Biology.* Univ. Chicago, Press, Chicago.

Chodos, A. and Detweiler, S. (1980). Where has the fifth dimension gone ? *Phys. Rev.,* **D21** : 2167-2170.

Hegstrom, R.A. and Kondepudi, D.K. (1990). The handedbess of the universe. *Sci. Am.,* **262** : 98-105.

Luisi, P.L. (1993). The chemical implemention of autopoiesis. *Proc. zool. Soc., Calcutta, Haldane Comm. Vol.,* 57-69.

Misra, K.K. (1992). Origin of life beyond replication. *Proc. zool. Soc., Calcutta,* **45** : 101-112.

Thirring, W. (1995). Do the laws of Nature evolve ? *In : What is Life ? The Next Fifty Years. Speculations on the future of Biology.* Murphy, M.P.. and O'Neill, L.A.J. (eds.) pp. 131-136. Cambridge Univ. Press, Cambridge.

□

MICROBIAL MODEL FOR MAMMALIAN DRUG METABOLISM AND ENVIRONMENTAL POLLUTION CONTROL

Timir Baran Samanta

Department of Microbiology, Bose Institute,

P1/12 C.I.T. Scheme VIIM, Calcutta - 700 054

Metabolism of drugs and control of environmental pollution are effected by a process known as biotransformation. Biotransformation essentially means enzymatic conversion of natural and synthetic molecules into substances having specifically modified structures. It is varied nature i.e. hydroxylation, dehydrogenation, esterification and/or deesterification, reduction, acylation/ deacylation and resolution of DL-mixture. Biotransformation has been tried both by mammalian and microbial enzymes depending on the substrate and type conversion. However, microbial enzymes/cells have outweighed its mammalian counterpart in the process although initial success was achieved by mammalian enzymes. Advantages inherent with the microbes are its simplicity of the growth media, regio- and stereospecificity. Moreover, one can prepare the product in quantity

by fermentation necessary for characterisation and clinical trial.

Among the biotransformations tried so far hydroxylation seems to be most important[1]. The hydroxylases or monooxygenases incorporate an oxygen atom into the substrates, which are usually hydrophobic in nature, into the hydrophillic one thus making their excretion from the system easy. The heme monooxygenases or more specifially Cyp_{450} linked monooxygenases are involved in most of the biological hydroxylations. This is a redox protein which acts as the terminal oxydase of the monooxygenase system. Cyp_{450} is an enzyme of the super gene family[2]. It is a b-type cytochrome which in its reduced state forms a binary complex with carbon monooxide. The binary complex has got the absorption maximum at 450 nm. This is a ubiquitious protein. Its ubiquity is paralleled by its avidity for organic substrates. The nature of the substrates varies from simple aliphatic hydrocarbon to complex phytoalexin. When one reviews the activity of this protein, he is perplexed with its behaviour. This is useful to detoxify the recalcitrant molecules. In so doing it very often leads to activation of organic molecules furnishing reactive intermediates which eventually bind to information macromolecules leading to chemical carcinogenesis[3].

With a view to understand the structure and function of this protein transformation of both endogenous and exogenous substrates was studied by microorganisms in our laboratory. Progesterone (endogenous) was converted exclusively to its 11α-hydroxy derivative both under *in vivo* and *in vitro* conditions by *Aspergillus ochraceus TS*[4-7]. The results of transformation by immobilized spores of *A. ochraceus TS* under reduced water activity were interesting. The pattern of transformation was changed; there was cleavage of C_{17}-C_{20} bond instead of 11α-hydroxylation by immobilized spores. The monooxygenases were resolved and it was found to be similar to that of microsomal system in mammals. The 11-oxygenase like other microbial monooxygenases is inducible in nature. Experiments with agents like phenobarbital (PB), methylcholantrene (3MC), TCDD and others showed that except benzo(a)pyrene all of them acted as gratitous inducers. The former got metabolised during induction. High pressure liquid chromatographic analysis of the BP metabolites revealed the presence of phenols, dihydrodiols and quinones of benzo(a)pyrene[8] - a profile exactly similar to the mammalian system. Thus *A. ochraceus TS* had been shown to have the capacity to metabolise both endogenous and exogenous substrates under the conditions used. Simultaneously it gives one an idea about the management of environmental polynuclear aromatic hydrocarbons (PAHs) by microbes.

The role of this protein in parasitic diseases is interesting but it is least studied. During our search on role of this enzyme in host-parasite interaction during Leishmaniasis it was observed that there is an imapirment of this enzyme in the host infected with *L. donovani* and the impairment is maximum on 21st day of infection[9]. It was interesting to note that the impairment of Cyp_{450} was accompanied by induction of nitric oxide synthease (NOS). Presumably the impairment of Cyp_{450} and induction of NOS hold the key to develop a combination therapy to combat the leishmanian infection which remains to be elucidated. The structure, function and evolution of this unique protein

(Cyp_{450}) will be discussed.

Selected References

Ronald E White and Minor J Coon (1980). *Ann. Rev. Biochem.* **49** : 315-56.
Daniel W Nebert and Frank Gonzalez (1987). *Ann. Rev. Biochem.* **56** : 945-93.
Carl E Cerniglia (1984). *Adv. Appl. Microbiol.* **30** : 31-71.
Timir B Samanta, N Roy and S Chattopadhyay (1978). *Biochem. J.* **176** : 593.
Dipak K Ghosh and Timir B Samanta (1981). *J. Steroid Biochem.* **14**: 1063-67.
Timir B Samanta and Dipak K Ghosh (1987). *J. Steroid Biochem.* **28** : 327-32.
Tapan K Dutta and Timir B Samanta (1997). *Bioorganic and Med. Chem. Lett.* **7** : 629-32.
Dipak K Ghosh, D Dutta and Timir Samanta (1983). *Biochem. Biophys. Res. Commun.* **113**
Timir B Samanta and Rittika Chanda (1998). *Indian J. Clin. Biochem.* **12** : 55-59.

□

DEFENCE AGAINST INTESTINAL NEMATODES

D. Mandal

Bidhannagar College, B.F. 142, Salt Lake, Calcutta - 700 064

The most fascinating aspect in symbiology is that for the parasites the host is almost the total environment. The ability of the parasites to resist or evade the defensive factors determines the ability of the parasites to be successfully adapted in the host. At the same time in the host-parasite interaction the extend of damages by the parasites cause the altered state of health i.e. disease in hosts.

At one time it was assumed that worms living in the gut lumen were effectively outside the body and they had no role either to initiate or be affected by immune response unless they damaged thhe host tissues. However this view has now been proved incorrect. The present discussion is aimed to focus some light on the protective immunity against some gastrointestinal nematodes of vertebrates.

Gut as the habitat

The vertebrate intestine can be considered one of the major ancestral sites for parasites (Wakelin, 1996). Large worms such as **Ascaris** necessarily live within the lumen, but the small species like hook worms and trichostronglyes have an intimate association with mucosa. Some species live within the mucosa tiself during their developmental stage, emerging into the lumen when mature; a few remain wholly or partially in the mucosal tissue through their life cycle in the intestine. Of these, **Trichinella spiralis** and species of **Trichuris** are thought to have intracellular locations, penetrating within the cells of the epithelial layer.

Parasite antigens

The antigens by namatodes are presented in a variety of ways - like

i) Somatic structure in general

ii) Stage specific compartments (eg. surface, excretion, secretion or somatic).

iii) The epitopoes of a single defined antigenic components.

Recently more precise antigen analysis is possible by the use of techniques like sodium dodecyl surface polyacrylamide gel electrophoresis (SDS-PAGE), immunobloting and monoclonal antibody production. Several reviews in this respect are available (Phillip and Rumjanek, 1984; Maizel and Selkirk, 1988; and Kennedy, 1990).

The antigenic properties of some of the intestinal nematodes are presented here. The structural organization of the cuticle varies between species to species but all are known to express antigenic molecules to which the host responds.

Ascaris itself is a potent source of allergen even to the researchers. Many molecules causing allergy have been described (Jerrell and Miller, 1982), but the molecule identified as ABA-1 with 10'14 KD (McGibbon *et al.* 1990) derived from the body fluid of both larval and adult forms of *A. lumbricoides* and *A. suum* has drawn special attention. This finding is especially important in context to immunopathology of human ascariasis

Toxocara canis is a zoo-anthroponotic nematode and is especially important because it is one of the first nematode in which active metabolically dependent transcuticular release of excretion-secretion antigen (ES) was demonstrated (Smith *et al.* 1981). All the major molecules are glycoprotein and the antibodies formed in host body were predominantly against carbohydrate.

The larval homogenates and the excretory-secretory products of both larva and adults of *Trichostrongylus colubriformis* are effective antigens. The more precise identification of the antigen has now become possible by gene cloning (Warren 1993). An intracellular polymeric protein - contortin which is closely associated with the microvillar membrene of the intestinal cells of the worm *Haemonchus contortus* is a potent antigen.

Host responses

Intestinal mucosa is considered to be one of the most effective barrier. The intestinal

nematodes are much subject to protective immune response as those living elsewhere in the body.

Intestinal Immunoglobulins

The dimeric Ig A secreted across the enterocytes is the major intestinal immunoglogulin. Similarly the IG M is transported across the epithelial cells. Ig G is produced locally by the plasma cells in the lamina propria and enters the intestinal tissue through blood circulation. Inflamation of the epithelial tissues induces the transport of Ig G. Ig E is secreted by the lamina propria plasma cells. Levels of complement within the mucosa are similar to those of either tissues but its function is not clear.

Lymphocytes

Both T and B lymphocytes are found abundantly in the lamina propria.

Myeloid cells

The populations of natural killer cells, macrophages, neutrophils, eosinophils, basophils and a subset of mast cells increase significantly during parasitic infection.

Protective immunity

Little is known about the protective response to intestinal nematodes in man. Most of the informations in this regard are available from the natural infections in sheep and cattle and some experimental models on rodents. In most, the infection stimulates responses that lead to expulsion of the worms at the stage of primary infection. This is sometimes referred to as "spontaneous cure".

The model of expulsion of some intestinal nematodes has been presented by Roitt *et al.*, 1993. The spontaneous expulsion depends upon two sequential steps, following antigen sensitization of specific T cells and B cells.

Ascariasis is characteristically associated with the allergic responses and the parasite itself is the potent source of allergens. There is MHC associated genetic control of Ig E antibody recognition of the allergen molecules. This is also known that human show marked variation in their ability to recognize the molecules.

The excretion-secretion antigens of *Toxocara canis* act as targets for protective immunity particularly antigen dependent cell mediated cytotoxicity. They contain allergenic components those induce eosinophilia and active complement.

Trichostrongylus is a parasite of sheep and has been adapted in guinea pig. Primary infection lasts for a few weeks before spontaneous cure. Secondary infections are expelled more rapidly. During infection, infiltration of a variety of cells like mast cells, eosinophils and basophils occurs

significantly. Amine released by the mast cells and basophils plays a major role for expulsion of the worms.

The contortin and a number of other intestinal membrane antigens have now been isolated from *Haemonchus* and used to immunize lambs against infection.

Selected References

Frankel, M.J., Savin, K.W., Bakker, R.E., Ward, C.W. (1989). Characterization of cDNA clones coding muscle tropomyosin of the nematode *Trichostrongylus colubriformis*. Mol. Biochem. Parasitol. **37** : 191-200.

Jarrett, E.E.E. and Miller, H.P.R. (1982). Production and activities of Ig E in helminth infection. Prog. Allergy, **31** : 178-233.

Kennedy, M.W. (1990). ed. "Parasitic Genes, Membranes and Antigens" Taylor and Francis, London.

Lightowlers, M.W. and Rickard, M.D. (1996). Excretory-seccretory products of helminth parasites : effects on host immune responses, Parasitology. S 166.

Maisels, R.M., Kennedy, M.K., Meghi, M., Robertson, B.D., Smith, H.V. (1987). Shared carbohydrate epitopes on distinct surface and secreted antigens of the parasitic nematode *Toxocara canis*. J. Immunol., **139** : 207-214.

Maizels, R.M. and Selkirk, M.E. (1988). Biology and immunochemistry of nematode antigens in "Biology of Parasitism : a Molecular and Immunologic Approach". (Englund, P.T. and Sher, A.F. Eds.) New York.

McGibbon, A.M., Christie, J.F., Kennedy, M.W., Lee, T.D.G. (1990). Identification of the major Ascaris allergen and its purification to homogeneity by high-performance liquid chromatography. Mol. Biochem. Parasitol. **39** : 163-172.

Phillip, M. and Rumjanek, F.D. (1984). Antigenic and dynamic properties of helminth surface structures. Mol. Biochem. Parasitol. **10** : 245-268.

Roitt, I., J. Brostoff and D. Male (1993). "Immunology" Mosby, Toronto.

Smith, H.V., Quinn, R., Kusel, J.R. and Guirdwood, R.W.A. (1981). The effect of temperature and antimetobolites on antibody binding to the outer surface of second state *Toxocara canis* larvae. Mol. Biochem. Parasitol. **4** : 183-193.

Wakelin, D. (1996). "Immunity to parasites : How parasitic infections are controlled". Cambridge University Press, Cambridge.

Warren, K.S. (1993). "Immunology and Molecular Biology of Parasitic Infections". Blackwell Scientific Publications. Boston.

□

THE IMPACT OF GENETICS ON THE HISTORY OF TWENTIETH CENTURY BIOLOGY

J.J. Ghosh
Department of Biochemistry
Calcutta University

From decentralising tradition to centralization

With the end of the twentieth century drawing nearer, it is high time to make a stock-taking of the important milestones through which biology has developed in the past one hundred years The future historians of biological sciences will emphasize two notable features about the progress of biology in the two halves of this century - in the first half of the 20th century the progress took place mainly in a decentralized manner with anatomy, cytology, histology, embryology genetics, physiology, biochemistry, evolution etc making their landmarks independently of each other, whereas in the second half of this century, genetics has played a central and integrative role in the progress of every branch of biology.

The failure of classical genetics to give early leadership helped classical biochemistry to come forward

The first decade of the 20th century biology started with two important conceptual milestones the coinage of the term "gene" (by the Danish geneticist Wilhelm Johannsen in 1909) and the term "Vitamins" (by the Polish biochemist Casimir Funk in 1910). Classical geneticists led by Thomas Hunt Morgan and his school at the Columbia University showed a myopic and conservative approach towards understanding the "gene" -- their studies gave "gene" a physical reality and their major interest remained confined at the level of understanding the arrangement and rearrangement of genes in the chromosomes Even being the acknowledged 'guru' of experimental genetics in his time, Morgan stoutly opposed any reductionistic approach towards clarifying the nature of gene and at the same time. Morganian genetics, centering around Drosophila, showed little interest in emphasizing genetic implications in embryology and evolution and as a result these sub-disciplines, being closely connected with genetics, drifted apart and developed in their own ways till the first three decades of this century. Unlike the situation in the field of classical genetics, the discovery of vitamins helped in the opening of the doorway to newer sub-disciplines like nutrition, metabolism, enzyme biochemistry etc. and all these paved the way for classical biochemistry to give leadership in biology in the first half of this century.

In 1930's and 40's, all the major roads in biology met to explore the nature of the gene

Throughout the decades 1930's and 40's, chemists, biochemists, quantum physicists, radiation biologists and biophysicists belonging to the phage groups, all were involved in a hot competition to win over the puzzling nature of the gene first. The chemists group under the leadership of P.A. Levene, made a historic misinterpretation in 1932, by stating that nucleic acids, containing unvarying, repetitive structures could never show any biological specificity like genes — this historic conclusion made by the chemists shifted all attention from nucleis acids towards searching other cellular constitutents serving as the genetic material. Biochemists, particularly belonging to enzyme school, believed (1930-40) that the genes must be proteins, which possess high specificity and catalytic properties. Even many protein chemists thought genes may well be nucleoproteins, because of Wendell Stanley's finding of the presence of both RNA and proteins in the TMV, crystallized in 1935. On the otherhand, the radiation biology school inspired by te historic findings of H.J. Muller (1926) on X-ray induced mutation, were convinced that mutation approach will enlighten the nature of the gene. The phase school, under Delbruck (1940) were also adamant that biophysical approach through phages will help to identify the nature of the gene.

The Merging of genetics with biochemistry and later on with biophysics opened the doorway to modern biology

Although historically the first bridge between genetics and biochemistry was laid by the British physician, Sir Archibold Garrod, in 1909 nobody did give any importance to this premature observations. In 1940, Beadle and Tatum at the Caltech first rediscovered this link by his historic conclusion of "one gene-one enzyme" hypothesis. This helped the subsequent investigator to track down thhe nature of the gene by conventional experimental approach. Gradually the idea about protein gene to nucleic acid gene was shifting as revealed by chronological events in the mid-40's, like Avery's premature claim of DNA being the chemical basis of heredity, which was unfortunately rejected and re-instated by the historic experiments of Hershey and Chase (1948). This was followed by te historic discovery of the double helix structure of DNA in 1953 by Watson and Crick, which ultimately disclosed the coherent picture of how gene replicates and regulates the biological function at the molecular level.

In the post-double helix era biology has made impressive advances

In the last forty five years, since the discovery of double helix DNA, the whole field of biological science is one the move, as never before in the long history of biology in the past. A strikingly rapid development in different sub-disciplines like developmental biology, molecular archaeology, molecular anthropology, molecular pharmacology, molecular epidemiology, molecular anthropology, molecular pharmacology, molecular epidemiology, molecular systematics, structural and functional

genomics, evolutionary biology, biotechnology etc.

Along with the pervasive developments in molecular biology, concepts about ecology and biodiversity have occupied a unique position in the 20th century biology — throwing new light on evolutionary biology and biodiversity.

Taking a glance to the next century's biology

Despite impressive advances in biology in this century — there are many current battle lines in biological sciences which will need the attention of the 21st century. These are genotype vs. phenotype views of evolution, information vs. metabolism as the basis of life, protein vs. RNA as the primordial biocatalyst, punctuation vs. gradualism in macroevolution, component vs. system approaches describing life's hierarchy, and which of our genes make us human etc.

Selected References

Cairns, J., Stent, G.S. and Watson, J.D. eds. (1966). Phage and the Origin of Molecular Biology. Cold Spring Harbour Lab, Long Island, USA.

Jacob, F. (1973). The Logic of Life : A History of Heredity Pantheon, NY. USA.

Olby Robert (1974). The Path of Double Helix, Univ. of Washington Press, Seattle, USA.

Judson, H.F. (1980). Reflections on the Historiography of Molecular Biology, Minerva **28**(3) : 369-421.

Kay, L.E. (1993). The Molecular Vision of Life, Oxford Univ. Press UK and USA.

□

HUMAN IMPACTS ON COASTAL — MARINE ECOSYSTEM AND ITS BIOTIC RESOURCES : AN OVERVIEW WITH SPECIAL REFERENCE TO DELTAIC SUNDARBANS

Amalesh Choudhury
Former Professor & Head
Department of Marine Science, Calcutta University

Preamble

The Coastal — Marine ecosystems of many countries contain some of the most biologically diverse and productive habitats but they are also the most vulnerable as well as the most abused marine zone. Coastal ecosystems are not only an important source of essential products for consumptive, commercial and recreational use, but also provide ecological services that directly benefit the people. Due to the many living and commercial opportunities it offers, the coastal zone sustain densely populated areas. Those areas are severely threatened by human activities, with consequent loss of their bio-diversity. The direct mechanisms include habitat loss and fragmentation, physical alternation, over- exploitation, pollution, introduction of alien Species and global climate change. Human activities have dramatically increased the intensity, pace and types of environmental changes with an impact upon the coastal habitats and the resources they sustain. Some types of exploration of living marine resources may change habitats and alter food webs, while coastal intensive aqua culture generates its own pollution and may upset ecological balances.

These changes may lead to the drastic decline of coastal fisheries and loss of biodiversity. The main root cause which drives these human activities lies in the high rate of human population growth, economic policies that fail to value the ecological services of the environment and its resources, insufficient scientific knowledge, and weakness in institutional and legal systems.

The Coastal Zone : Specificities

Coastal — Marine zones constitute some of the world's most productive zones. The offshore sectors provide valuable marine resources including high protein food while the on - shore sectors feature amongst the most sought after for areas in terms of residential settlement and trade as well as other business opportunities (Ex : Digha-Sankarpur, Diamond Harbour, Kakdwip, Namkhana — Frazergunge, Canning, Gosaba, etc.).

To focus more specifically on our region, we note that tropical marine environments are characterised by high species diversity. Which are less tolerant of changes in their surrounding. "The Sum effect of their characteristics generally result in tropical organisms and communities more susceptible to disturbances or pollution than their corresponding counterparts in temperate

Seas" (Bryceson, 1990).

The shallow tropical coastal — Marine areas have traditionally supported very protective ecosystems viz., Coral reefs and Mangrove Swamps from which aquatic resources are harvested. These systems support multiple valuable services in addition to their natural defense functions against coastal erosion. All marine coastal areas that are subject to storm flooding by the sea; all intertidal areas of mangroves, marsh, deltas, saltflats, tideflats and beaches; all permanent shallow coastal water areas such as bays, lagoons, estuaries, deltaic water ways and near coast waters that include sea grass meadows, coral reefs, shellfish beds, submerged bars or barrier reefs; the near shore coastal waters and all small coastal islands (Clark, 1990).

The Coastal areas of Indian subcontinent contain some of the world's richest ecosystems including extensive coral reefs (Andaman and Nicobar Archipelago, Gulf of Manner and Lukshadweep and Minicoy Archipelago, mangrove forests of Gangetic delta and Andaman and Nicobar Islands, estuaries viz., Hooghly-Matla estuary and Mahanadi, Godavari, Krishna and Kaveri estuaries. They support wide bio-diversity and the coastal populations derive many economic benefits from these systems. However, within the context of development pressure, poverty, food security, as well as ineffective planning management and lack of environmental awareness that many parts of our country faces today, the healthy survival of all these critical ecological areas cannot be but threatened.

Exploitation of marine living resource

In the Indian Ocean region, fishing is a victim of pollution rather than a source of it, however, the fact remains that utilization of marine resources that takes place without concern for the interactions between different components of the marine environment. Two major issues must be mentioned : first, industrial fishing carried out by foreign fishing fleets as well as domestic trawl boats which have negative effects on habitats and stocks and second, the over exploitation of coastal — marine resources attributable to rising human population, degradation of land and shortage of land based jobs, in short the depletion of resources and the poverty cycle.

A new population area of intervention in the Coastal — marine ecosystem is marine or brackish water aqua-culture development.

Human impact on the coastal zone

This overview of human impacts upon coastal ecosystems brings to light the following major issues.

1. The coastal zone constitute some of the world's most productive areas in terms of fishing and other marine living resources, agricultural production, leisure opportunities as well as business and other economic opportunities.
2. Tropical marine environments are characterised by high species diversity all of which perform

vital economic and critical ecological roles.

3. Many of the ecological areas are highly sensitive to change. Under normal conditions of development, such critical ecological units adopt to nature but when the rate of change is rapid, adaptation is difficult and there can be severe environmental degradation.
4. The level of funding and research devoted to the stewardship of the coastal-marine environment is despodently low.
5. Industrial activities carried out on land have a strong bearing upon the coastal environment. Examples of *hotspots* occur all around the maritime states of India (as for example — Calcutta-Howrah-Haldi complex), but the development trends are such that these *hotspots* could become more persistent unless mitigative measures are sought to address the problems.
6. Concurrent utilization of maine resources without concern for the interaction between different components of the coastal environment threaten the functional integrity of natural coastal ecosystems and could mitigate against the long term sustainability of coastal resources as well as the livelihood of coastal population.
7. Ineffective planning and management of coastal zones, the absence of environmental impacts assessment, inadequate incorporation of environmental issues into feasibility projects, population pressure as well as economic expansion are threatening integrity of the natural ecosystems. All over the coasts of deltaic Sundarbans and coastal Midnapore including Digha — Sankarpur, there are examples of indiscriminate use of coastal resources which are landing to diminishing returns as well as the degradation of environmental quality.

Selected references

Bryceson, I. *et al.* (1990). State of the environment in the Eastern African regional UNEP regional Seas Reports and Studies No. 113, UNEP.

Clark, J. (1990). Integral management of coastal seas resources, Draft Report prepared for FAO.

Choudhuri, A.B. and Choudhury, A. (1994). Sundarbans Mangrove Ecosystem. Vol. I. IUCN, GLAMD, Switzerland.

GESUMP (1990). The state of the Marine Environment. UNEP regional seas Reports and studies. No. 115.

Neshyba, S. (1987). Oceanography : Perspectives of field Earth. John Wiley and Sons. New York.

□

MICROTOMY, MICROSCOPY & ANIMAL SURGERY

Prof. B.R. Maiti
Department of Zoolgy, University of Calcutta

The most common procedure used in the study of tissue is the preparation of histological sections that can be studied with the help of the light microscopy. Since tissues and organs are very thick for transillumination, they must be sectioned. In some cases, very thin layers of tissues or transparent membranes of living animals (e.g. the mesentery, the tail of a tandpole or the wall of a hamster's cheek pouch) can be observed in the microscope by transillumination and without first sectioning the tissue. Nevertheless, in most cases, tissues must be sliced into thin sections by fine cutting instruments called microtomes.

In order to avoid tissue digestion by enzymes (autolyses), or bacteria, tissues must be promptly and adequately treated with fixative following removal from the animal's body. This treatment is fixation, usually consists of submerging the tissue in stabilizing or cross-linking agents or perfusing them with the fixatives. One best fixative for routine microscopy is a buffered isotonic solution of 4% formaldehyde. Formaldehyde and glutaraldehyde are known to react with (NH2) group of tissue proteins. Glutaraldehyde helps to reinforce cross-link proteins. Because of high resolution of electron microscope, a double fixation procedure, using a buffered glutaraldehyde solution followed by a second fixation in buffered osmium tetroxide is recommended. Osmium tetroxide preserves and stains lipids and proteins.

Freezing microtome

To avoid loss of lipids from the tissues during xylene treatment, a freezing microtome has been devised in which tissues are hardened at low temperature to permit sectioning. The freezing microtome and its more elaborate and efficient successor, the cryostat (Gr. Kryos - Cold + Statos - standing) permits sections to be obtained quickly without going through the embedding procedure.

Staining

With few exceptions, most tissues are colourless, so it is difficult to study them unstained in light microscope. Most histological dyes behave as acidic or basic compounds and forms electrostatic (salt) linkages with ionizable radicals of the tissues. Tissue components that stain more readily with basic dyes are termed basophilic (toluidine blue, methylene blue, haematoxylin) and those with an affinity for acid dyes are termed acidophilic (orange G, eosin, acid fuchsin). Nucleoproteins, glycoseaminoglycans and acid glycoproteins are stained by basic dyes where as mitochondria, secretory granules and collagen are stained by acid dyes. In addition, impregnation with such

metals as silver and gold is commonly used, especially in the studies of the nervous system.

Dyes generally have two chemical groups auxochrome and chromophore. Auxochrome carries electrical charge, cationic (NH_2^+) or anionic (OH^-, $COOH^-$, SO_3^-) which binds with the chromophore. The chromophore may be of different types such as quinonoid (haematoxylin), nitro (picric acid) or azo (orange G for RBC or janus green for mitochondria) configurations. During staining tissue protein binds with the cationic polyvalent metallic part of the mordants by means of two OH groups in one hand and the mordant (Aluminium) in turn binds with the dye by means of other two OH groups and eventually forms a tissue-mordant-dye complex which is visible under the light microscope.

Light microscopy

Conventional light, phase contrast, polarizing, confocal and fluorescence microsccopy are all based on the interaction of photons and tissue components. Stained preparations are usually examined by transillumination. Microscope is composed of both mechanical and optical parts. The mechanical part is known. The optical compounds of a microscope consist of three systems of lenses, the condenser collects and focuses the illumination to produce a cone of light that illuminates the object, the objective lens enlarges and projects the illuninated image of the object in the direction of the ocular lens which further magnifies this image and project it onto the viewers' retina or a photographic plate. The total magnification is obtained by multiplying the magnifying power of the objective and ocular lense.

Resolutions

It is the smallest distance between two small objects separated by a distance of a size similar to that of the object. Consequently, the two small objects are distinctly visible under the microscope. The maximum resolving power of a light microscope is around 0.1 µm. This permits good images magnified 1000-1500 times. Objects smaller than 0.1 µm cannot be distinguished with light microscope.

$$\text{Resolution} = \frac{\lambda}{2\,NA}$$

(λ = wave length of radiation of light = 0.5 µm. 2 NA = Numerical aperture of condenser lens and Numerical aperture of objective lens.
NA = 0.25 for 10 x objective lens).

$$\text{or} \quad \text{Resolution} = \frac{0.5\ \mu m}{2 \times .25} = 1\ \mu m$$

Phase contrast microscopy

The principle of phase contrast microscopy is based on the fact that light changes its speed and direction when passing through cellular and extracellular structures with different refractive indices. These changes cause the structure to appear lighter or darker relative to each other.

Polarizing microscopy

When normal light passes though a polarizing filter, it exits vibrating in only one direction. If a second filter is placed in the microscope above the first, with its main axis perpendicular to the first filter, no light passes through, resulting in dark field effect. If tissue structures containing oriented molecules such as, cellulose, collagan, microtubules, and microfilaments, are located between the two polaroid filters, their repeatitive, oriented molecular structures allow them to rotate the axis of light emerging from the polarizer. Consequently, they appear as bright structures against a dark back-ground. The ability to rotate the direction of vibration of polarised light is called birefingence and is present in crystalline substances or substances containing oriented molecules.

Confocal microscopy

This type of microscopy uses lasers and computers to produce three-dimensional images of living cells and tissue slices. Because of the way in which the image is produced, the investigator can visually dissect through the specimen, observing structures above or below others. Storing information from each visual plane of the section in a computer allows a three dimentional image to be reconstructed.

Fluorescence microscopy

When certain fluorescent substances are irradiated by light of a proper wave length, produced by mercury vapour or xenon gas lamps or halogen filament lamp, they emit light with a longer wave length. In fluorescence microscopy, tissue sections are usually irradiated with ultraviolet light so that the emission is the visible portion of the specimen. The fluorescent substances appear as brilliant, shiny particles on a dark background.

A microscope with a strong UV light source is used and special filters that eliminate UV light are used after the objective lens to protect the observers eye. Some naturally fluorescent substances are normal constituents of cells, such as Vitamin A, Vitamin B_2, porphyrins or chlorophyll. Other fluorescent compounds that have an affinity for tissues and cells are used as fluorescent stains (dyes, chemicals and antibiotics which are called as "fluorochromes"). Induced fluorescence is applied to substances such as catecholamines which after treatment with formaldehyde vapour are converted to fluorescent quinoline compounds. Acridine orange is most widely used, because it can combine with DNA and RNA, when observed in the fluorescence microscope, the DNA acridine orange complex emits a yellowish-green light, and RNA - acridine orange complex emits a reddish-

orange light. It is then possible to identify and localize nucleic acids in the cells.

Fluorescence microscopy is a method of analysing the light emitted by a fluorescent compound in a microspectrophotometer. It can be used to characterise several compounds present in cells and is of particular importance in the study of catecholamines. The development of fluorescent probes (substances that react specifically with cell components) permits highly sensitive assays for various substances within cells.

Electron microscopy

Both transmission and scanning electron microscopy are based on the interaction of electron and tissue compounds. The electron microscope is an imaging system that permits high resolution (0.1 nm). In practice a resolution of 1 nm in tissue sections is considered satisfactory, and permits enlargement upto 400 times greater than those achieved with light microscope.

The principle is that a beam of electron can be deflected by electromagnetic fields in a manner similar to light deflection in glass lenses. Electrons are produced by high temperatures heating of a metallic filaments (cathode) in a vacuum. The emitted electrons are then submitted to a potential difference of approximately 60-100 KV or more between the cathode and anode. The anode is a metallic plate with a small hole in its centre. Electrons are accelerted from the cathod to anode. Some of these particles pass through the central hole of the anode, forming a constant stream (beam) of electrons. The beam is deflected by electromagnetic lenses in a way roughly analogous to what occurs in the optical microscope. Thus, the condenser focuses the beam at the object plane and the objective lens forms an image of the object. The image obtained is further enlarged by one or two projecting lenses and is finally seen on a fluorescent screen or is projected onto photographic plate. As electron microscopy requires a much thinner sections (0.02 - 0.1 μm), embedding is performed with a hard epoxy plastic. The blocks are so hard that glass or diamond knives are necessary to section them. Since the electron beam in the microscope cannot penetrate glass, the extremely thin sections are collected on small metal grids. Those portions of the section spanning the holes in the mesh of the grid can be examined in the microscope.

Cryofracture (Free Fracture)

It is sometimes used with the electron microscopy, allows the examination of tissues without fixation and embedding. Artefacts are fewer than with other methods, because cell membranes are often split open, details of their internal structure can also be seen.

Scanning electron microscopy

A variant of electron microscopy, scanning electron microscopy, permits pseudo-three-dimensional views of the surfaces of cells, tissues and organs. The very narrow (10 nm) electron beam is moved sequentially from point to point across the surface to be examined. At each point,

the primary electron beam interacts with a thin metal coating previously applied to the specimen and produces a reflected a emitted electrons. The electron signal fluctuation is captured by a detector that modulates the brightness of a cathod ray tube whose electron beam is being moved (scanned) in synchrony with the primary electron beam of the microscope. The resulting photographs are easily understood, since they present a view that appears to be illuminated from above.

Radioautography

It permits the localization of radioacitve substances in tissues by means of the effect of emitted radiation on photographic imulsions. Silver bromide crystals of emulsion act as microdetectors of radioactivity. In radioautography, tissue sections from animal previously treated with radioactive substances are covered with photographic imulsion and stored in a lightproof box in a refrigerator. After various exposures times, the slides are developed photographically and examined. All silver bromide crystals hit by radiation are reduced to small black granules of elemental siler, indicating existence of radioactivity in the tissue structure. This procedure is suitable for both light and electron microscopy. If a radioactive protein precursor (amino acid) is given to a protein synthesizing cell, its pathway can be followed in the cell after varying period of time. The intensity of the process is proportional to the number of granules formed in the tissue components.

Animal surgery

Animal surgery is generally practiced in farm and domesticated specimens in a similar way to that of humans. Apart from this, surgery is also done for academic interest for ascertaining functions of a particular endocrine or exocrine or other organs on their respective targets. Various methods are devised like surgical ablation, chemical inhibition and inactivation of a specific product of the organ such as testicular testosterone (Leydig cell) or inhibin (Sertoli cell product) using respective antibody.

Procedure

Animals to be operated should not be given food for at least 8-10 hours prior to surgery for maintaining them in low metabolic activity during surgery. Anaesthetic agents like ether, chloroform are usually applied externally to the animals in a glass chamber till the animal is deeply anaesthetised with a slow consistent breathing, the condition which is suitable for surgery. When the animal attains deep anaesthesia, it must be removed immediately from the anaesthetic chamber and put to a clean, sterilized surgical tray with ether musk for short-term surgery. For longtime surgery, barbitone sodium is injected intravenously at a particular dose (0.01 mg/100 gm body wt.) which will keep the animal under anaesthesia for 30-45 minutes or more. This procedure is suitable for metal cannulation in the 3rd ventricle of the brain of bird or rat for direct application of drugs like substances P for induction of thirst or neuropeptide Y for release of GnRH.

If castration or oophorectomy is required in rat, the animal is anaesthetised with ether/ chloroform and one and a half inch incision is given near the lower midventral plane of the animal, first by cutting the skin followed by incision of the abdominal muscle. In case of male castration testes are exposed by pulling out the fat body which will be visible after laparatomy. While pulling out the fat body the testis associated with the fat body will also be pulled out, ligate the spermatic blood vessels along with the fat body near the epididymal area with fine nylon or silk thread tightly. Then only the testis and not any other organ is surgically ablated with fine scissors with negligible or no bleeding. After testicular ablation, the exposed organs of the animal should be sterilized with absolute alcohol and carefully pushed back to the viscera and both sides of the skin and abdominal muscle of the operated site should be stiched carefully with nylon thread and suture needle tightly and closely so that the stich is not removed until the healing is over. Regular dressing (sterilization) of the animal with absolute alcohol and neosporin powder/cream must be followed at least for 5/7 days.

Bilateral castratian results in the dysfunction of all the sex accessories; ventral prostate is most sensitive to androgens as compared to other sex accessories. Sex accessories dysfunction can be detected gravimetrically, histologically, histochemically as well as from biochemical standpoint. This result will clearly indicate the importance of testis vis-à-vis androgen which is essential for functioning of the sex accessories.

Selected References

Bancroft, J.D. and Stevens, A. (1996). Theory and Practice of Histological Techniques. 4th Edition, Churchill and Livingstone : New York.

Janqueira, L.C., Carneiro, J. and Kelley, R.O, (1995). Basic Histology. 8th Edition, Appleton & Lange : Prentice-Hall International, Inc. : New Jersey.

Zarrow, M.X., Yochim, J.M. and McCarthy, J.L. (1964). Experimental Endocrinology. Academic Press : New York.

□

TRANSPORT ACROSS THE CELL MEMBRANE AND THE ABSORPTION OF DRUG

Malaya Gupta

Department of Pharmaceutical Technology,

Jadavpur University, Jadavpur, Calcutta 32

A drug is used for prophylactic, therapeutic or experimental purposes. It must reach the site or sites at which an action is wanted and a sufficiently high concentration of the drug must be maintained there long enough for the desired effect to be achieved. The concentration of a drug at its site of action is clearly determined by the balance between the rates of arrival at and clearance from this site. Whatever may be the root of drug administration it is distributed to the various part of the body to produce systemic effect. After absorption drugs circulate into the blood either in the free form or bound to plasma proteins. Some drugs absorbed in inactive form and converted to active metabolites of the parent drug eliciting the desired therapeutic effect. The protein bound form is therapeutically inactive. It forms a depot near the site(s) of action. From the depot the free drug is slowly released and enter within the cell. It affects the cellular metabolic pathway(s) and thereby produces the desired effect. Ultimately cellular effect is converted to systemic effect and thereby action in the living body is noted. Each cell is closed by a *plasma membrane*. To reach the site of action, a drug must have to penetrate the *plasma membrane*.

The *plasma membrane* is a thin, continuous, film-like quasifluid membrane of 6-9 nm thickness. Proteins, lipids and carbohydrate constitute about 52%, 40% and 8%.

Membrane models

Gorter-Grendel lipid bilayer model

Gorter-Grendel (1925) proposed that the erythrocyte membrane is composed of lipid bilayer consisting of two monolayers at amphipathic lipid molecules. The polar head-grups of lipid monolayer is direct towards the water adjoining the outer surface of the membrane. While their nonpolar hydrocarbon tails are oriented into the middle core of the bilayer (Fig.1).

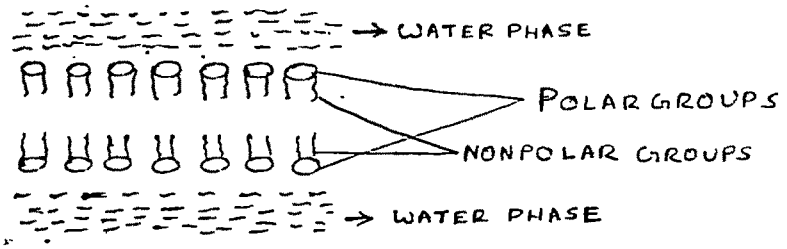


FIG 1) The lipid bilayer model

Davson-Danielli trilaminar model

Davson-Danielli (1935) proposed a trilaminar model of the membrane. They proposed that the lipid bilayer is bounded on either side by a continuous layer of globular polar proteins (Fig.2). The globular protein is supposed to be electrostatically held by the charged plar head groups of the adjoining lipid monolayer of the middle bilayer.

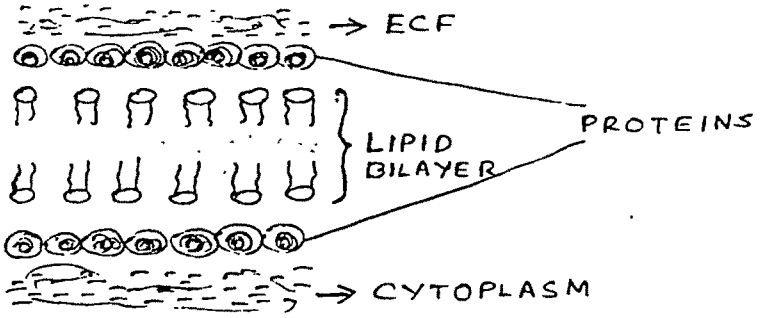


FIG 2) TRILAMINAR MODEL

Singer-Nicholson fluid mosaic model

Singer-Nicholson (1972) proposed a fluid mosaic model of the membrane. A fracture face, passing along the midline between the lipid monolayer, is noted under electronmicroscope and contains bristles with many particles. Such particles evidently remain deeply embedded in the lipid bilayer and extend across the fracture face. Phospholipid and proteins are redistributed in the membrane, indicating its fluidity. Membrane contains a continuous quasifluid lipid bilayer in which many globular protein molecules remain embedded as a discontinuous mosaic particles interupting the continuity of the lipids at scattered points (Fig.3). Some of the membrane proteins extend either considerably into both monolayers or all across the lipid bilayer. Mucopolysaccharides are noted at the indistinct age of the cell. The three dimensional structure of the membrane forms a definite pattern. It is a "buillabaisse" with the solid proteins float in the lipid soup. It can be referred as "lipid sieve" membrane.

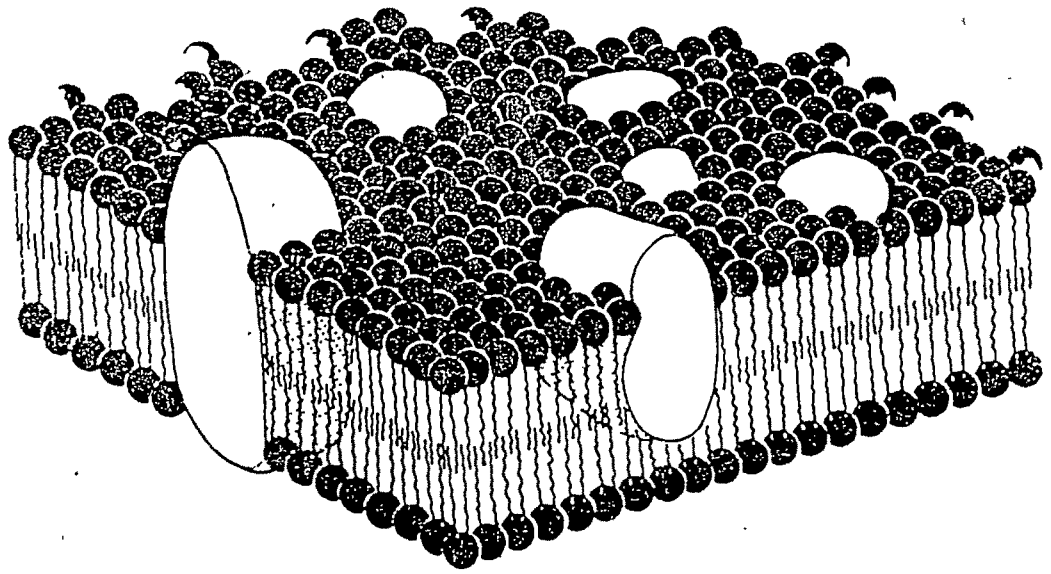


Figure 1 Schematic view of a cell membrane showing a liquid bilayer with protein molecules embedded in the matrix

Mechanism of Absorption

Substances first fix on the receptor. Fixation takes place by enzymatic model/electron sharing/ electrostatic/Vander Wal forces/hydrogen bond/hydrophobic bond. After fixation to the receptor side, substrates or drugs either in the original form or in the modified form cross the cell membranes by two mechanisms, e.g. *passive transport process and specialised active transport.*

Passive transport process

Drug molecules penetrate the cell membrane either by filtration or by diffusion. Filtration is the process by which small water soluble molecules cross the cell membrane through the water filled pores in the membrane. This flow is the result of hydrostatic/osmotic pressure differences across the membrane.

Diffusion : Drugs which are lipid soluble get dissolved in the lipid of the cell membrane and cross it by diffusion. Drugs molecule simply by jig-jaw way cross the membrane and directly proportional to the concentration gradient.

Active transport process

It is applicable in case of lipid insoluble water soluble large particles. It exhibits selectivity, saturability and requires energy. It is mediated by carriers which are considered to be components of cell membrane. The carrier transport may be of three types —

1. When the drug carrier complex moves across the cell membrane against a concentration gradient or in case of ions against an electrochemical potential gradient, it is active transport proper. It shows selectivity and saturability. Absorption of Na is by this process.
2. When the drug-carrier complex does not move against the concentration gradient, it is called faciliated diffusion. It shows selectivity, saturability and blockade by metabolic inhibitors. Glucose absorption is by this process.
3. When the drug-carrier complex moves from one surface to the opposite surface and after releasing the drug, the carrier react with another substance which it returns to the original surface it is called exchange diffusion, e.g. in the distal tubule of the kidney, sodium is reabsorbed in exchange of H or K.

Factors influencing Drug absorption

Solubility : Absorption of drug is dependant upon solubility of the drug. Drugs given in solutions are more rapidly absorbed than those given in solid form. An insoluble drug may not be absorbed at all.

Physical and chemical state of the drug : A drug in colloidal state is absorbed less rapidly than crystalloid state. Ionized forms of drug are poorly absorbed.

Absorbing surface : Large the absorbing surface greater is the absorbtion.

Routes of drug administration : Drug absorbtion depend on the route of administration. Absorbtion from intramuscular injection is greater than subcutaneously.

Presence of interfering/fascilitating substances : For example iron absorbtion enhanced by protein and ascorbic acid and inhibited by phosphates/phytates.

Vascularity of the absorbing surface : If the part is more vascular absorbtion is more in amount and conversely absorbtion is less if circulaton is inadequate.

Selected References

Crossland, J. (1980). Lewis Pharmacology, 5th Edn. Churchill Livingstone, Edinburgh, London, N.Y.

Das, D (1994). Biochemistry 8th Edn. Academic Publishers, Calcutta.

Ghosh, B.N. Text book of Pharmacology.

Richards, W.G. (1977). Quantum Pharmacology. Butterworth & Co Ltd.

□

O_2 - CO_2 TRANSPORT — A PHYSIOLOGICAL "SYMBIOSIS"

M.S. Ghosal

Department of Zoology, University of Calcutta

35, Ballygunge Circular Road, Calcutta 700 019

An animal - organism has evolved arrangements for transporting oxygen from the external environment to the cells as well as removal of CO_2 from the site of production to the external environment. Thus exchange of respiratory gases occurs at two places - (i) at the respiratory organ where O_2 enters the blood from external environment and CO_2 from blood goes to the same environment; (ii) at the tissue level where O_2 leaves the blood and goes to the cells and CO_2 produced in the cells enter the blood. Inflow of O_2 into the blood is favoured by removal of CO_2 from the blood and removal of CO_2 from the blood also facilitates entry of O_2 into blood. A similar situation is also seen at the tissue level. Removal of O_2 from blood is favoured by entry of CO_2 into the blood and entry of CO_2 into blood favours removal of O_2 from blood.

Hemoglobin is the most important respiratory pigment. A critical analyses of O_2-CO_2 transport with hemoglobin clearly reveal the interaction between them.

O_2-transport

The pO_2 in the external environment is higher than deoxygenated blood. Hence O_2 enters blood by diffusion. A very small amount O_2 (3%) goes into physical solution and the remaining 97% combines with hemoglobin and forms oxyhemoglobin. In these forms O_2 is transported through blood and reach the tissues. In the tissue space, pO_2 is less than the arterial blood and so, O_2 diffuses through the capillary wall and enters tissues space. The oxygen-hemoglobin dissociation curve shifts to the right and P_{50} for O_2 is increased if pCO_2 of blood is increased. Thus, when CO_2 enters blood at the tissue level, the affinity of O_2 with hemoglobin is decreased and delivery of O_2 to the tissues is increased. Similarly when the blood is at the lung level. CO_2 goes out and this increases the affinity of O_2 for hemoglobin. P_{50} for O_2 is decreased and oxygenation of hemoglobin is facilitated.

CO_2 transport

pCO_2 is high in the tissue cells where it is elaborated. It moves down the pCO_2 gradient to the tissue space and then enters blood where it is carried in different forms. About 5% is carried in physical solution, 7% as carbamino compound and 88% as bicarbonate. It is mainly carried as $KHCO_3$ in erythrocytes and $NaHCO_3$ in plasma. CO_2 after entering blood goes to erythrocytes. Here it forms $KHCO_3$. From it $NaHCO_3$ is formed in the plasma by chloride-shift mechanism. It has

been found that reduced hemoglobin is necessary for the formation of $KHCO_3$. It has also a higher capacity for the formation of carbaminohemoglobin. Thus removal of O_2 at the tissue level will favour uptake of CO_2 by increasing formation of bicarbonate and carbamino compounds.

At the lung level, when O_2 enters blood, oxyhemoglobin is formed. It is necessary for the formation of CO_2 from $KHCO_3$. $NaHCO_3$ of plasma gives rise to $KHCO_3$ in erythrocytes by reversed chloride - shift and from it CO_2 is produced subsequently. Moreover, as oxyhemoglobin is formed, CO_2 is released from carbaminohemoglobin, because oxyhemoglobin has less affinity for the formation of carbaminohemoglobin.

CO_2 absorption curve of blood reveals that presence of erythrocytes is essential for the formation of bicarbonate in plasma. Moreover, CO_2 content of blood is more in presence of deoxyhemoglobin. Hence, deoxygenation of hemoglobin at the tissue level favours uptake of CO_2 and oxygenation of hemoglobin at the lung level facilitates CO_2 removal for blood.

Molecular mechanism of O_2 - CO_2 interaction

Hemoglobin exists in two forms or in conformational state, the deoxygenated T or 'taught' form and the oxygenated R, or "relaxed" form. In the T-form, electrostatic bands a salt bridges are formed between and within hemoglobin subunits. It has less affinity for O_2. With the progressive oxygenation of hemoglobin, the salt bridges are gradually weakened and broken. This results in the formation of R-form which has more affinity for O_2. The transition from one stage to another has been calculated to occur at about 10^8 times in the life of a red blood cell.

Any factor that breaks the salt bridges and favours formation of R-form will favour oxygenation of hemoglobin. On the other hand, the factors which will favour formation of salt bridges and thus formation of T-form, will also facilitate dissociation of O_2 from oxyhemoglobin. At the tissue level when CO_2 enters into erythrocytes it is hydrated and converted to H_2CO_3 by cabonic anhydrase. H_2CO_3 dissociates into HCO_3^- and H^+. The protons (H+) bind to the C-terminal histidine residues (His-146) of the B chains of oxyhemoglobin. Such protonation helps to re-establish the salt bridges and thus favours the transformation of R-form to T-form. Hence, dissociation of O_2 from oxyhemoglobin is facilitated and thereby delivery of O_2 to the tissue space is increased.

At the lung level, when O_2 binds with the T-structure, the salt bridges are broken and protons are released from the nitrogen atoms of the histidine residues (His-146) of B chains. The protons (H+) combine with bicarbonate and H_2CO_3 is formed. Carbonic anhydrase causes release of CO_2 from H_2CO_3 and CO_2 goes out into the lung alveoli.

Increased pCO_2 decreases the affinity between oxygen and hemoglobin. This is called Bohr effect. Similarly decreased pO_2 increases CO_2 content of blood. This is called Haldane effect.

Removal of O_2 from oxyhemoglobin favours formation of bicarbonate and carbamino compound from absorbed CO_2. Compared to oxyhemoglobin, the deoxyhemoglobin binds more H^+ and forms three fold more carbaminohemoglobin. So, deoxygenation of hemoglobin at the

tissue level favours CO_2 transport. The process is reversed at the lungs. As hemoglobin is oxygenated CO_2 is released from carbaminohemoglobin. Secondly protons are released from hemoglobin which binds with bicarbonate and forms H_2CO_3. It then dissociates into $CO_2 + H_2O$ by carbonic anhydrase and CO_2 goes out into the lungs.

Selected References

Ganong, W.F. (1997). Review of Medical Physiology. 18th Edn. Prentice-Hall International, Inc.

Murary, R.K., Granmer, D.K., Mayers, P.A., Rodwell, V.W. (1996). Harper's Biochemistry, 24th Edn. Prentice-Hall International Inc.

West, J.B. (1990). Physiological basis of Medical Practice. 12th Edn. B.I. Warenly Pvt. Ltd.

Das, D. (1993). Biochemistry. 8th Edn. Academic Publishers.

Knut Schimidt - Nielsen (1990). Animal Physiology. 4th Edn. Cambridge University Press.

Prøsser, C.L. (1973). Comparative Animal Physiology. 3rd Edn. W.B. Saunders Company.

□

FILARIASIS AND MOSQUITO

Goutam Chandra

Department of Zoology, Burdwan University,

Burdwan, West Bengal

Introduction

Human filariasis has been recorded in Indian subcontinent as early as the 6th century B.C. by famous physician Sushruta in Sushruta Samhita. He described the two varieties of the disease as vriddhi (scrotal tumour) and slipadam (elephantiasis of the leg). Sushruta described slipadam as the disease which gave rise to swelling from inguinal region to thigh, knee and finally foot. This was attended with pain at intervals, fever and burning sensation. According to him the disease used to be confined to legs and hands and some extensive swelling of the affected part, exudation and knotty growths were incurable (Harnle, 1897; Ray, 1902; Vishagaratna, 1907; Seal, 1915; Garrison, 1917).

Bancroftian filariasis

The clinical features produced in bancroftian filariasis were observed and described by ancient Hindu savants and by Persian physicians like Rhazes, Avicenna who referred this disease as *Elephantiasis arabicum* (Faust & Russel, 1964).

The clinical features of filariasis now-a-days differ very little from the description of Sushruta, described more than 2500 years age. Modern therapeutic knowledge supports the prognosis of the disease as predicted by that famous physician.

No further knowledge of this disease was added for twenty five centuries, till after the middle of nineteenth century, a series of events occurred focussing this disease. In 1863, the French surgeon, Demarquay discovered the embryo of a nematode from chylous hydrocele fluid of a patient in Havana, Cuba. He observed the same nematode larvae in 1868 and 1869 in chyluria patients. Wucherer of Brazil found the embryo in the chylous urine of man in August 1866; but these particulars were not published till 1868 (Wucherer, 1868). In 1872, Timothy Lewis found this microscopic nematode larva in the peripheral blood and urine of a patient in Calcutta for the first time (Lewis, 1877). Joseph Bancroft in December 1876 found the adult female parasite in an abcess from the arm of a Chinese in Brisbane and sent the same to Cobbold who named, it *Filaria bancrofti* and published the news in July 1877 in the Lancet (Cobbold, 1877), about a month before findings of this parasite by Lewis in Calcutta (Lewis, 1877).

The discovery of the mosquito as the intermediate host and biological vector of the filarial worm was made by Sir Patrick Manson and was communicated through Cobbold to the Linnean Society in October 1878. He pointed out the necessity of a blood sucking arthropod for intermediation and development of filarial worm. Manson (1883) gave the description of the dramatic metamorphosis of the filarial embryo to the adult form in his book "The Filaria Sanguinis Hominis". Cobbold accepted the work of Manson in March 1878 and wrote unreservedly "Manson's remarkable discovery of the intermediate host" (Manson-Bahr & Alock, 1972).

T.L. Bancroft of Brisbane proved conclusively that the infective embryos of the filarial worms entered into human system through the skin when they were deposited on it during their act of biting by the mosquitoes bearing them. He also noticed that the microfilariae required 16-17 days in the mosquito to reach the infective stage (Bancroft, 1899). This view was corroborated by Low (1900) in England and James (1900) in India.

Since Wucherer was the first to discover the embryo now known as microfilaria and Bancroft Joseph) the adult, this filarial worm later received the new nomenclature *Wuchereria bancrofti* (Cobbold, 1877).

Microfilaria of *W. bancrofti* are nocturnally periodic. This observation was supported by many scientists from different tropical countries. Several theories as to the factors involved which are responsible for nocturnal periodicity have been put forward but none of these is adequate to explain the phenomenon (Manson, 1883; Korke, 1928a; Iyenger, 1933; Raghavan & Krishnan,

1949; Hawking & Thurston, 1951). In 1956, McFadzean & Hawking proved that the periodicity of *W. bancrofti* may depend on changes in the difference of oxygen tension between venous and arterial blood by day and night. During day time, the microfilariae accumulate in the lungs where the oxygen tension is high. They merge to hold themselves in the pulmonary capillaries by some force which is increased by the rise in oxygen tension and decreased by its fall. Masuya (1976) sugested that the microfilariae possess a photosensitive substance containing a vitamin A - like carotenoid similar to visual pigments in fluorescent granules in the epidermis which cause them to leave the peripheral circulation in day light and collect in the lungs. Periodic microfilariae possess numerous granules in subperiodic and aperiodic forms which have few or none.

Mosquito and Disease

Culex quinquefasciatus (Say, 1823) is the principal man-biting tropical member of the *Culex pipiens* complex, distributed upto 38° North in USA, 30° North in Asia and only 24° North in Africa. The species is the most potential transmitter (vector) of nocturnally periodic form of *W. bancrofti* in the tropical regions, although West African strains of *W. bancrofti* do not develop in this species (Manson-Bahr & Bell, 1987). A high infection rate has also been recorded by several workers during their study on experimental transmission and natural infection of *W. bancrofti* to *C. quinquefasciatus* (Mansfield - Aders, 1927; Korke, 1928b; Rao & Iyenger, 1932; Raghavan & Krishnan, 1949; De & Chandra, 1994; Chandra *et al.*, 1993).

Zoogeographical distribution indicates that *W. bancrofti* is present throughout the tropical regions of Asia. Africa, the Pacific and the Americas (Hawking, 1976a,b,c, 1977). The nocturnally periodic form of this filarial parasite occurs in almost all the tropical and subtropical countries in a considerably widespread but focal distribution pattern. It has disappeared from the North America and Australia as well as from some islands in the Caribbean and has greatly reduced in the last 25 years in the Americas, specially in Brazil. But its prevalence is one the gradual increase in the growing towns of Asia except in the China and Japan. It has greatly and dramatically reduced in China recently (WHO, 1992). The rural forms adapted to anophelines (such as *An. gambiae*) are common in East and West Africa. Recently *Anopheles punctulatus* and *An. koliensis* have been detected as vector of *W. bancrofti* in East Sepik Province of Papua New Guinea (Bockarie *et al.*, 1996). The day biting mosquitoes of the genus *Aedes* (such as *Ae. polynesiensis, Ae. samoanus*, etc.) transmit the diurnally subperiodic form in the rural areas of South Pacific. The diurnally subperiodic *W. bancrofti* transmitted by *Ae. niveus* (Tewari *et al.*, 1995) is found in two small communities of Nicobar Islands. A nocturnally subperiodic form is found in the jungles of Thailand (Manson-Bhar & Bell, 1987).

Public health problem

At present lymphatic filariasis is a major public health problem, ranking second just after

malaria among the six major diseases in the tropical and subtropical countries. According to the Report of the Expert Committee of Filariasis (WHO, 1992), a total of 751 million people were at risk of lymphatic filariasis throughout the world and 72.8 million had filarial infection, either having microfilariae in their blood or having one or more acute or chronic filarial lesions. In India alone, altogether 374 million people were at risk of filariasis and 45 million bad been suffe ing from different filarial aetiologies (WHO, 1992).

A more recent detailed assessment of available information has attempted to correct for age, gender, and disease specific biasis in the earlier figures and it estimates that approximately 119.1 million individuals are now infected with lymphatic filariasis world wide, 106.2 million having bancroftian filariasis and 12.9 million having brugian filariasis. The number with overt physical disabilities from their infections is approximately 43 million, with bancroftian filariasis accounting for almost all (40 million) of these cases (WHO, 1994; Micheal & Bundy, 1995).

Brugian infection is endemic in 8 countries in Asia while *Wuchereria* occurs in 7 countries in the American, 4 in the Eastern Mediterranean region, 7 in South-East Asia and 7 in the Western-Pacific; an additional 38 countries lie within the *W. bancrofti* endemic areas of Sub-Saharan Africa. India and Sub-Saharan Africa have very similar burdens of *W. bancrofti* infection like 45.5 million cases and 40 million cases, respectively. Individually these regions account for about 38% and 34% respectively of the total world burden. The regional estimates for brugian filariasis indicate that China (32%) and India (20%) account for half of the global burden, with the South-East Asian countries of Indonesia, Thailand, Malaysia, Philippines, Viet Nam and South Korea accounting for the rest (WHO, 1994).

Microfilaraemia and disease are highest in the 45-60+ age group. Gender-specific estimates reveal that microofilaraemia is higher in males than in females, apparently 10% more cases in brugian filariasis. Chronic diseases caused by *Wucheria* are more prevalent in males due to the large number of hydrocele cases (26.8 million) but lymphoedema cases are 18% higher in females (7.81 millions) than males (5.36 million). For brugian filiariasis both microfilaremea (males 6.52 million and females 3.84 millions) and lymphoedema (males 1.8 millions and females 1 million) appear to be higher among males (WHO, 1994). Acute diseases are less obviously age dependent than do chronic manifestation (Pani *et al.*, 1991). The frequency of adenolymphangitis in individuals does appear to increase with age and the severity of chronic manifestations (Pani *et al.*, 1995). The frequency of acute episodes is believed to be related to the progression of chronic diseases, but it is not known whether the episodes are determined by intercurrent microbial infection, immunological mechanism or exposure to infective mosquito bites (Pani *et al.*, 1995). Infective bites may occur throughout night but the chances of having infective bites was highest during the 3rd quadrant (12.1 a.m. to 3 a.m.) of night (Chandra, 1995). According to WHO estimates in 1984 throughout the world, 78.6 millions were Infected, of which 41.3 millions were the inhabitants of India (WHO, 1984). Recent estimates indicate that the figures have risen in last 10 years by 37.5

millions throughout the world and by 4.2 millions in India. So the prevalence or danger of the disease is in a steady rising state.

The National Filariasis Control Programme (NFCP) is a part of National Malaria Eradication Pogramme (NMEP) in the Ministry of Health. The NFCP budget is appox. 30 million rupees per year. Primary control strategies include larviciding and environmental control measures for mosquito reduction in urban areas, as well as screening urban population by night blood surveys and treating with DEC. Though 75% of the population at risk lives in rural areas, all filariasis contol efforts are confined to urban areas and practically no assessment of the impaet of control efforts is routinely carried out. More precise and sincere efforts combined with effective community participation are necessary for the fruitful control and improvement of these worst possible filarial situation.

Conclusion

Lymphatic filariasis is more widespread and inflicts a very much greater disease burden worldwide than was recognised even five years ago at the time of the last evaluation of WHO Expert Committee on the control of Lymphatic Filariasis (WHO, 1992). The ability of new simplified, effective and affordable control strategies together with the recent designation of lymphatic filariasis is one of only six infectious diseases considered eradicable or potentially eradicable (CDC, 1993), makes this an ideal time to initiate a global programme to control or eliminate this disease from all endemic countries and to assert the optimistic expectation that such a programme will be successful (WHO, 1994).

Selected References

Bancroft, T.L. (1899). *J. Prof. Roy. Soc. New South Wales* **82** : 62-83.

Bockarie, M., Kajura, J., Alexander, N., Dagoro, H., Bockarie, F., Perry, R. and Alpers, M. (1996). Transmission dynamics of *Wuchereria bancrofti* in East Sepik Province, Papua New Guinea. *Am. J. Trop. Med. Hyg.* **54** : 577-581.

CDC (1993). Recommendations of the international task force for disease eradication. *Morbidity and Mortality Weekly Report* **42** : 1-38.

Chandra, G. (1995). Peak period of filarial transmission. *American J. Trop. Med. Hyg.* **53** : 378-379.

—., Banerjee, A., Majumdar, G. and Hati, A.K. (1993). *Wuchereria* infection in the natural population of *Culex quinquefasciatus* in Calcutta. *Bull. Cal. Sch. Trop. Med.* **41** : 5-7.

*Cobbold, T.S. (1877). On *Filaria brancrofti. Lancet* **11** : 1-39.

De, S.K. and Chandra, G. (1994). Studies on the filariasis vector. *Culex quinquefasciatus* at Kanchrapara, West Bengal (India). *Indian J. Med. Res.* **99** : 255-258.

Faust, E.C. and Russel, P.F. (1964). *Clinical Parasitology*. Lea and Febiger, Philadelphia.

Garrison, F.H. (1917). *An Introduction to History of Medicine*. W.B.. Saunders Co, Phhiladelphia.

Harnle, A.F.R. (1897). *The Sushruta Samhita*, Calcutta.

Hawking, F. (1976a). Distribution of human filariasis throughout the world. Part I; the Pacific region including New Guinea. *Trop. Dis. Bull.* **73** : 347-373.

—., 1976b. Distribution of human filriasis throughout the world. Part II. Asia. *Trop. Dis. Bull.* **73** : 967-1016.

—., 1976c. Distribution of human filariasis throughout world. Part IV. America, *Trop. Dis. Bull.* **76** : 693-710.

—., 1977. Distribution of human filariasis throughout the world. Part III, Africa. *Trop. Dis. Bull.* **74** : 649-679.

—. and Thurston, J.P. (1951). The periodicity of microfilariae 1. The distribution of microfilariae in the body. *Trans. Roy. Soc. Trop. Med. Hyg.* **45** : 307-340.

Iyenger, M.O.T. (1933). Filariasis in Trivandrum. *Indian J. Med. Res.* **20** : 921-937.

James, S.P. (1900). On the metamorphosis of the *Filaria sanguinis Hominis* in mosquitoes. *Brit. Med. J.* **2** : 533-537.

Korke, V.T. (1928a). Observations on filariasis in British India Part II. *Indian J. Med. Res.* **16** : 187-198.

—. (1928b). Observations on the filariasis in some areas in British India, Part III. *Indian J. Med. Res.* **16** : 187-198.

*Lewis, T.R. (1877). The microscopic organisms found in the blood of man and animal and their relation to diseases. *14th Ann. Re. Sanitary Commissioner,* Govt. of India, Appendix B. pp. 102-157.

Low, G.C. (1990). A recent observation on *Filaria nocturna* in *Culex*: Probable mode of infection of man. *Brit. Med. J.* **1** : 1456-1457.

Mansfield-Aders, W. (1927). Notes on Malaria and Filariasis in the Zanzibar Protectorate. *Trans. Roy. Soc. Trop. Med. Hyg.* **21** : 207-214.

Manson-Bahr, P.E.C. and Bell, D.R. (1987). *Manson's Tropical Disease.* 19th eds., ELBS Pub. pp. 353-354 and pp. 1429-1430.

—. and Alcock, A. (1972). *The Life and Work of Sir Patric Manson.* Cassell & Co. Ltd., London.

Manson, P. (1883). *Filaria Sanguinis Hominis.* H.K. Lowis. London.

Masuya, T. (1976). Cited from Manson-Bahr, P.E.C. & Bell, D.R. (1987). *Manson's Tropical Disease.* 19th (eds.) ELBS Publication.

McFadzean, J.S. and Hawking, F. (1956). The periodicity of microfilariae V. Stimuli affecting the periodic migration of the microfilariae of *W. brancrofti* and of *Loa loa* in man *Trans. Roy. Soc. Trop. Med. Hyg.* **50** : 543-562.

Micheal, E. and Bundy, D.A.P. (1995). The global burden of lymphatic filariasis. In : *The Burden of Disease,* (eds.) C.J.L. Murray & A.D. Lopez. Geneva, World Health Organization.

Pani, S.P., Balakrishnan, N., Srividya, A. Bundy, D.A.P. and Grenfell, B.T. 1991. Clinical epidemiology

of bancroftian filariasis : effect of age and gender *Trans. Roy. Soc. Trop. Med. Hyg.* **85** : 260-264.

—., Yuvaraj, J., Vanamail, P., Dhanda, V., Michael, E., Grenfell, B.T. and Bundy, D.A.P. (1995). Episodic adenolymphangitis and lymphcedema in patients with bancroftian filariasis. *Trans. Roy. Soc. Trop. Med. Hyg.* **89** : 224-230.

Rao, S.S. and Iyenger, M.O.T. (1932). Experimental infection of some Indian mosquitoes with *Wuchereria (Filaria) bancrofti. Indian J. Med. Res.* **20** : 25-34.

Raghavan, N.G.S. and Krishnan, K.S. (1949). A note on experimental infections of microfilaria of Malayi (Brug) in *Culex fatigans* and *Anopheles stephensi. Indian J. Malar.* **3** : 249-252.

Ray, P.C. (1902). *A History of the Hindu Chemistry.* Bengal Chemical & Pharmaceutical Works, Calcutta.

WHO Expert Committee report on Filariasis (1992). Lymphatic filariasis : the disease and its control. *Wld. Hlth. Org. Tech. Rep. Ser.* **821**: 1-31.

WHO Report of a consultative meeting held at the Universiti Sains Malaysia, Penang, Malaysia, (1994). Lymphatic filariasis infection and disease : Control strategies. *TDR/CTD/FIL/ PENANG/94.1,* P. 1-30, World Health Organization.

WHO Expert Committee report on Filariasis (1984). *Tech. Rep. Ser. No. 702, WHO* : 7-90.

Seal, B.N. (1915). *The Positive Science of the Ancient Hindus.* Longman's Green and Co., London.

Tewari, S.C., Hiriyan, J. and Reuben, R. (1995). Epidemiology of subperiodic *W. bancrofti* infection in the Nicobar Islands, India. *Trans. Roy. Soc. Trop. Med. Hyg.* **89** : 163-166.

Vishagaratna, K.L. (1907). *Sushruta Samhita* : (English translation).

□

BIOLOGICAL MEMBRANE AND SIGNAL TRANSDUCTION

Amar Bhaduri

Indian Institute of Chemical Biology, Calcutta

Biological membranes can no more be regarded as inert barriers that simply protect a living cell from outside mileau. The Singer Nichloson model of semi-fluid membrane structure has been validated by enormous amount of experimental data over two decades. The transmembrane or intergral proteins of plasma membrane are crucial for biological energy transduction [e.g. photosynthesis or oxidative phosphorylation], cell-cell communication, hormone action, cellular differentiation and controlled cell division. These proteins can be receptors, carriers, channels, enzymes and pumps. The message from outside is received by this proteins and then transduced, amplified and if necessary taken to the genomic level for expression of message. Cyclic AMP, G-proteins, Ca^{2+}, protein kinases and phosphatases and specific transcription factors are components of these cascading message systems. The basic idea will be introduced with cAMP as second messenger and then developed to highly complex systems like mitogens growth factors and oncogenes.

Selected References

Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (1989). Molecular Biology of the cell. 2nd Edn. Gerland Publishing Inc. New York and London.

Harton, H.R. *et al.* (1996). Principles of Biochemistry, 2nd Edn. Prentice Hall International Inc. New Jersey.

Stryer, L. (1995). Biochemistry. 4th edn. W.H. Freeman & Company, New York.

□

BIOTECHNOLOGY : SCIENCE, APPLICATION AND FUTURE — AN INDIAN PERSPECTIVE

Amar Bhaduri

Indian Institute of Chemical Biology, Calcutta

Great and spectacular discoveries of Molecular Biology spanning over a period of four decades have provided us with a molecular framework for understanding the main principles of information storage and transfer that constitutes the essence of life. We now know that genes are nothing but pieces of DNA on an enormously long, continuous DNA strand or chromosome that dictate synthesis of numerous proteins and enzymes that are responsible for all the chemical reactions of a living system.

Genes can now be isolated at will from one organism and transferred to a completely different organism giving almost a 'new' form of life. This transgenic technique, that cuts all the boundaries of phylogenetic scale, is at the heart of modern Biotechnology and is certain to have profound effect on medicine, agriculture, environment management, chemical and pharmaceutical industry. The whole human genome will be fully known by the year 2005. New drugs, vaccines, engineered seeds and plants are already hitting the market. Transgenic animals, plants and microbes will have tremendous impact on our life-style in coming decades.

The developed countries led by USA and advised by giant multinationals want to protect the gains of this scientific revolution for commercial exploitation by extending the scope of patent rights to this emerging area of biotechnologicals and new life forms. New ethical questios are also cropping up. What should be the guiding principle for India in this global scenario ?

This lecture will briefly outline the science behind this technology and then address some of the relevant questions.

Selected References

Higgins, I.J. *et al.* (1985). Biotechnology Principles and Applications. 1st Edn. Blackwell Scientific Publication. London.

Smith, J.E. (1988). Biotechnology. 2nd Edn. Edward Arnold, London.

□

BIODIVERSITY AND SUSTAINABLE DEVELOPMENT IN AN ECOLOGICAL PERSPECTIVE — AN OVERVIEW

N.C. Datta

Department of Zoology, University of Calcutta

Biodiversity has now become a common catchphrase. Like other global environmental issues such as global warming and ozone layer depletion in the stratosphere, biodiversity is now not only a focal point of discussion, but also an issue of combative controversy. Indeed, lots of animated discussion leading even to unresolved confrontations have taken place at the EArth Summit at Rio in 1992. However, it is gratifying to note that despite dissensions, the intrinsic value of biodiversity has rightly been recognised and its ubiquitous concern in systematics, ecology, evolution, genetics,biotechnology, industry, economics, agriculture, aquaculture and environmental impact assessment are duly recognized. The social, economic, cultural, and aesthetic value of biodiversity have also highly been appreciated. The convention on biologicl diversity under preparation since 1988, was finalized just before the United Nations Conference on Environment and Development (UNCED). This international agreement, a legally binding treaty, signed by over 170 countries, had come into force in early 1994. It is needless to say that the biodiversity convention has culminated in a vibrant ecopolitical encounter of the present decade.

What is biodiversity ?

The implicit meaning of the term biodiversity is indeed very simple and etymologically it means the multiplicity or heterogenity of biota, the flora and fauna including the microbes, colonizing the planet earth. In this connection it may be emphasized that the kinds and classes of biota alone do not necessarily constitute biodiversity in its entirety. Virtually, from ecosystem point of view, biota can hardly be separated from the habitat, the physical space and the factors of the environment with which these form an integrative unit. In view of the above statement, biodiversity may holistically be defied as the sum of varied ecosystems, the intergral parts of which are diverse biota as well as innumerable microbes and different kinds of habitats. Biodiversity has also been defined as the "**global composite of genes, species and ecosystem**". Yet again, it has also been defined as "**variety and variability among living organisms and the ecological complexes in which they occur**". Obviously, therefore, biodiversity is a comprehensive term and needs close study from various points of view. Without biodiversity, nature would have been stale and monotonous.

Origin of Biodiversity ?

Biodiversity is the product of time. Nearly 4 billion years ago life originated. With the travel of

time, life after origin on one hand changed, flourished and diversified, occupying almost all hostile and hospitable niches of the global habitat establishing the maxim that "Nature abhors vacuum" and on the other, many living forms silently vanished through ages partly during natural selection and partly due to other natural changes in the geosphere. It is well established that great mass extinction of species took place in different geological periods as a sequel of global climatic changes like repeated cooling and warming, oceanographic circulation, rise in sea level and catalysmic geological events like tectonic movements, volcanic eruptions etc.

Kinds of Biodiversity

When critically analysed, hierarchy in biodiversity may be identified. At the lowest level is the genetic diversity which accounts for the variety of genetic information possessed by different individuals of the same species. Very little is known about the genetic and biochemical variability of species.

Habitat or substratum harbours the biota. Habitat diversity is caused by geomorphological and climatic changes in lithosphere, hydrosphere and atmosphere. Truly speaking, habitat diversity sustains faunal and floral diversity. However, biodiversity starts at the genetic level culminating to the ecosystem state successively through species, population and community levels.

Whittaker suggested three kinds of biodiversity;

1. ***Alpha (species) diversity***— the diversity within a specific habitat. It gives an idea of the total number of species occurring in a definite habitat.
2. ***Beta (habitat) diversity***— the diversity between different habitats or cross habitat diversity, measured as the gradient of change in diversity along different sites or communities.
3. ***Gamma (landscape) diversity***— the total diversity of a whole geographically or ecologically defined region or landscape.

According to UNEP there are about 30 million species on the earth of which only about one and half million have ever been described and about one quarter of the earth's species risk extinction within next 30 years.

Indispensability of Biodiversity

Perhaps by now it is explicit that biodiversity is hardly from being a mere assemblage of diverse habitats and their inhabitants, rather it is intimately associated with almost all the essential ecological processes which uphold the life support system of the planet earth. Fixation of solar energy, production of organic matter, decomposition and transformation of dead biota for the use of the producers, maintenance of CO_2-O_2 balance, biogeochemical cycles are largely mediated by diversity of biota. Sustainable agriculture and aquaculture solely depend on biodiversity. The present day high yielding crops are the products of some wild varieties. According to one estimate at least

50,000 varieties of rice were cultivated once in India. But with the advent of the Green Revolution, a handful of so called high yielding varieties are encouraged for cultivation. If the biodiversity of crop plants does not exist, the scope of developing new strains will be difficult. Many plant and animal species in the wilderness may have immense therapeutic potentialities. Natural products from various plants and animals may serve as a panacea for many dreadful diseases. A tropical periwinkle plant is said to provide antileukemic chemical and sea squirts have been reported to contain antiviral and anticancer drug. Many such life saving drugs can be obtained from wild plants and animals.

Biotechnology holds a great promise in the field of industry, agriculture and medicine. Microbes, as well as, plants and animals are indispensable for the development of biotechnological strategy. About 40 varieties of neem biopesticide have been patented by American concerns. Micro-organisms collected from Indian soil have also been patented and will be employed for industrial purposes, primarily for the production of antibiotics. Japan has also taken Indian soil for the extraction of bacteria and other microbes for industrial application. Many developed countries have their own gene banks where a huge collection of biological material is stored. The farmers of U.S.A. make an estimated profit of 150 million dollars per year from a gene for barley plant that happens to be resistant to yellow dwarf virus. The said gene was originally taken from Ethiopia.

Conservation of Biodiversity

The rate of loss of biodiversity as a part of natural process is rather slow. But man made ecodegradation puts biodiversity under serious threat. Since biodiversity is our natural resource and since it is essential for the survival of human kind, therefore, preservation of biodiversity in a sustainable manner is our solemn duty.

Preservation of biodiversity may be done in *in situ* and *ex situ* methods. In *in situ* method, all steps to preserve a component of biodiversity (flora, fauna etc.) are taken in the place of its natural distribution. As a result, the share of the dividend of biodiversity may be enjoyed by the people where it occurs. Whereas in *ex situ* preservation the biodiversity component will have to be transferred to a place outside its normal area of distribution. The state or country importing the biodiversity will tend to enjoy its fruits, depriving very often the whole or its genetic material which will serve as the mother material for future use is transferred. Technology for istalling germplasm bank is now well known. *Ex situ* preservation of genetic material has become a serious concern for the underdeveloped and developing knowhow. Once the developed countries with full grip of biotechnological knowledge are able to manage *ex situ* storage of genetic material of a species of potential economic value, they go for patenting it and monopolise the product and the process as well. Under such circumstances, the developing countries are compelled to buy back with exorbitant price their own genetic material. A number of intriguing questions are involved with biodiversity conservation. However, preservation of biodiversity is indispensable not only for ecologic and

economic reasons but also for aesthetic and ethical logic. We must remember that man is incapable of creating a species and therefore he does not have the right to annihilate it.

Real threat ot our civilisation is not pollution but loss of biodiversity. pollution can be prevented/ abated and polluted habitat can be restored but a species once lost is a loss forever.

Sustainable Development

Sustainable development was the 'leitmotif' of the Brundtland Report. Development is said to be sustainable when it "meets the needs of the present without compromising the ability of future generations to meet their own needs". Development is desired to fulfil the material, moral and aesthetic aspirations of mankind and his society. Unlike economic growth, development is a qualitative concept and sustainability is a doctrine indicating the notion of unkeeping and perpetuation of the dividend of development over time. Developing countries are confronted with the problems of overgrowth of population, overload of debt, proverty and poor technological infrastructure, although some of them are rich in biodiversity. Sustainable development extensively (although not exclusively) depends upon biodiversity where it stands for biological or ecological resource. Barbier (1987) identified three systems as basic to any process of development : **the biological or ecological resource system, the economic system and the social system.** If these three systems remain in isolation without any integration, the development will be unsustainable and development will be sustainable only when the system goals overlap, interact and form an integrative unit. Sustainable development is our ultimate goal to obviate poverty and to maintain total well being of mankind.

Selected References

Kothari, Asish (1994). Conserving Life, Kalpavriksh, New Delhi.

Odum, E.P. (1997). Ecology (A bridge between Science & Society). Sinauer Associates.

Starke, Linda (1990). Signns of Hope. Oxford Univ. Press, New York.

Wilson, E.O. and F.M. Peter (Edt.) (1988). Biodiversity. National Academy Press. Washington, D.C.

World Commission on Environment and Development (1987). Our Common Future. Oxford Univ. Press, Delhi.

THE METABOTROPIC AND IONOTROPIC RECEPTORS IN THE AUTONOMIC JUNCTIONS

Tusharkanti Ghosh

Department of Physiology

Surendranath College, Calcutta - 700 009

The chemical transmission in the autonomic junctions was initially noted by Otto Lowei and Henry Dale. Later chemical transmission has been found to occur in the synapses of the central nervous system (CNS). In both the sympathetic and parasympathictic division, the preganglionic motoneurones use acetylcholine (ACh) as the neurotransmitter. The post-ganglionic cells in the parasympathetic system are cholinergic while in the parasympathetic system postganglionic neurons are noradrenergic. However, the sympathetic postganglionic neurons in the sweat glands and in the blood vessels of skeletal muscle are cholinergic. Several contransmitters have been identified in the autonomic neurons. In the cholinergic sympathetic preganglionic neurons enkephalin is found. Vasoactive intestinal polypeptide (VIP) is released with acetylecholine in some autonomic neurons. Neuropeptide Y and ATP are found in the post-ganglionic noradrenergic neurons Dopamine is secreted by the interneurons in the sympathic ganglia. The different neurotransmitters and neuropeptides act on specific receptors with distinct properties.

The membrane bound receptors on which neurotransmitters act are of two types : Ionotropic receptors (or class 1) and Metabotropic (or class 2). The ionotropic receptor consists of channel proteins that themselves bind the neurotransmitter molecule, inducing an allosteric change in the channel to allow ions to flow. These receptors transduce the chemical signal into an electric signal over a brief time scale (less than a millisecond) and is responsible for classical synaptic transmission. nicotinic acetylcholine receptor (nAChR), glycine receptor, $GABA_A$ receptor, α-amino-3-hydroxy-5-methyl-isoxazole-4-propionic acid (AMPA) receptor, N-methyl-D-aspartate (NMDA) receptor are the examples of ionotropic receptors. Metabotropic receptors are nonchannel proteins which after binding with the neurotransmitter induce changes in the guanine nucleotide binding proteisn (G-proteins). G-proteins, in turn, influence distant enzymes or channels to produce longlasting response (tens of millisecond). G-protein coupled enzymatic cascades usually generate intracellular second messenger. Metabotropic receptors play primarily a modulatory role in the synatic transmission and are often involved in distant types of communication between neurons. The examples of metabotropic receptors include α-adrenergic receptors (α_{1A}, α_{1B}, α_{1D}; α_{2A}, α_{2B}, α_{2C}) β-adrenetic receptors (β_1, β_2, β_3), muscarinic acetyl choline receptors (M_1, M_2, M_3, M_4, M_5), dopaminergic receptors (D_1-D_5), neuropeptide Y receptors and VIP receptors.

The transmission of impulse in the sympathetic ganglion appears to be a simple relay from

pre- to postganglionic nerve. However, studies of synaptic organization have shown that ganglion is a complex integration system. The stimulation of preganglionic fibres in frog gives rise to a sequence of synaptic effect in a ganglion cell; a fast EPSP, lasting 20-30 msec; a slow IPSP, lasting 2 Sec; a slow EPSP, lasting 30 sec; late slow IPSP, lasting several minutes. The fast EPSP is mediated by nAChR involving an increased conductance to cations (Na^+, Ca^{++}, K^+). The slow IPSP is due to the stimulation of dopamine receptors (D_2) which hyperpolarize the membrane by turning off Na^+ conductance. It has been proposed that preganglionic nerves excite an interneuron that inhibits ganglion cells by releasing dopamine. These cells are called small intensely fluorescing (SIF) cells as these cells fluoresce with the paraformaldehyde technique. SIF cells contain large dense core vesicles. The slow EPSP is due to a decrease in a resting K^+ conductance and as a result the membrance depololarzes toward sodium equilibrium potential. The stimulation of M_2 muscarinic acetylcholine receptor (mAChR) produces this response. The last response, a late slow EPSP, is believed to be mediated by gonadotropin - releasing hormone (GnRH). The suppression of the resting K^+ current is the mechanism for this response. The stimulation of postganglionic nerves causes changes in the gland cells or smooth muscle cells. The changes are produced by a family of α adrenergic receptors and a family of β adrenerigic receptors.

The dopaminergic receptors, α and β adrenergic receptors, VIP and neuropeptide Y receptors and mAChR share a common architectural theme. According to the hydrophobicity plots they consist of seven putative transmembrane domains and therefore referred to as seven transmembrane (7TM) receptors. They are also known as serpentine receptors. They all turn out to be members of an extremely large superfamily of evolutionarily related proteins. The 7TM sections from the pillars of a hollow column or a pocket. Neurotransmitters are thought to occupy binding sites deep within the central cavity of the column. On the externalside of the membrane the lengthy N-terminal end probably provides the necessary binding sites for the neuropeptides. There are three extracellular loops labelled as e-1, e-2, and e-3. The 7TM receptors have three cytoplasmic loops (i-1, i-2, i-3) and the carboxyterminal tail fo the molecule is present inside the cell. The cytoplasmic loops and tail are crucial to G-protein binding, with the i-3 particularly concerned with recognizing particular G-protein. The phosporylation of serine and threonine residues in the C-terminal tail due to the activity of protein kinase A (PKA) may cause desensitization f the 7TM receptors.

G-proteins in the biomembranes help in the signal amplification. G-proteins may be either stimulatory (G_s) or inhibitory (G_i). The structure of G-proteins consists of a large (45 kDa) subunit and smaller β and γ subunits. The α subunit has a guanine binding site. Both the α and γ subunits have fatty acid "tails" which attach them to the inner leaflet of subsynaptic membrane. This attachment ensures the three dimensional orientation in the membrane which is important for the interaction of G-proteins with receptors and effectors. There may be several isoforms of G-proteins within a single cell, each activated by more than one receptor and acting on more than one target.

In the resting state subunit binds to a GDP and it has strong affinity for βγ-dimer. When this resting G-protein collides with a ligand activated receptor, GDP will be released and a GTP molecule will be picked up in its place. As a result the α subunit is dissociated from the heterotrimeric structure and comes into contact with an effector which is activated to perform its biochemical functions. This effector may be an adenylyl cyclase or a phospholipase C-β (PIP_2 phospholipase). The effector also activates GTPase activity of the G-protein to hydrolyze GTP to GDP. Adenylyl cyclases catalyze the synthesis of cAMP. The most important "second messenger" in animal cells which in turn activates the cAMP-dependent protein kinase. The activation of phospholipase C-β results in the production of two second messengers : inositol 1,4,5-triphosphate (IP_3) and diacylglycerol (DAG), M_1-, M_4-, M_5-mAChRs and α_1 adrenergic receptors use IP_3 and DAG as second messenger. The activity of M_2, M_3-mAChRs, dopamine receptors (D_1-D_5), α_2- and β_2-, β_3-adrenergic receptors is mediated by cAMP.

The nicotine acetylecholine receptor (nAChR) is a pentameric protein which shows structural diversity in the mammalian skeletal muscle, electric organ of the electric eel, autonomic ganglia and in the CNS. In the electric eel and mammalian muscle it is made up of five subunits : There are two identical α subunits and one β, one γ, and one δ subunit. Each subunit has four hydrophobic intrammabraneous sequences which are labelled M1-M4. Each sequence is 19-27 amino acids in length. Unitl fairly recently it was proposed that each sequence assumed an α-helical conformation. This is challenged nowadays. It has been suggested that the M2 is α helical and strongly contributes to the lining of the pore but the other sequences may take the form of β strands. Each of these outer sequences could make one or three passages through the membrane. These five subunits are arranged in a nearly symmetric fashion around a channel that is wide open outside the cell and narrows as it goes through the cell membrane. There is a binding site for acetyl choline on each a subunit. An additional sequence M5, between M3 and M4, has been reported in the a-subunit. This M5 sequence may be present in the cytoplasm or in the membrane. The N-terminal and C-terminal ends are present in the extracellular compartment. The four subunits are encoded by four different genes.

In the autonomic ganglia nAChRs are heterapentameric and are made up of α_3, α_5, α_7, β_2 and β_4 subunits. There appears to be two postsynaptic types. AChRs in the CNS have a different subunit composition, consisting of α-β-α-β-β. The nAChR is a member of a superfamily that includes $GABA_A$ and glycine receptors. The channel in nAChR is nonselective for cations (Na^+, Ca^{++}, K^+), producing a net inward flow of positive charge when activated by ACh binding.

Selected References

Ganong, W.F. (1997). "Review of Medical Physiology", 18th edition, Appleton and Lange, Stamford, USA.

Smith, C.U.M. (1996). "Elements of Molecular Neurobiology" 2nd edition, John Wiley & Sons,

Chichester, UK.
Sphepherd, G. (1988). "Neurobiology", Oxford University Press, Oxford.

□

HYPERTENSION : CAUSES AND REMEDIES

S. Chatterjee
Department of Physiology, University of Calcutta,
92, A.P.C. Road, Calcutta - 700 009

High blood pressure or hypertension has become one of the major causes of disability and death in India today. More than 70 million people are suffering from hypertension. If they are not treated with proper medication, diet and living habits, they may die of heart attack, stroke, kidney failure, blindness. Ironically of all the known ailments that can lead to premature death, hypertension is the easiest to control.

Our heart beats about 72 times a minute. At every heart beat about 60 ml of blood is punped into the arteries. Contraction of the heart is called systole and relaxation of the heart is called diastole. The blood pressure peaks, when the heart contracts i.e., systolic pressure and decreases when heart relaxes i.e., diastolic pressure. Systolic pressure eminus diastolic pressure is known as pulse pressure, which is the pressure head to maintain blood flow within our closed circulatory system.

Pressure applied to a confined fluid is transmitted equally in all directions. Blood pressure is defined as lateral pressure exerted by blood in the wall of the vessels through which blood flows. The normal range for an adult blood pressure measured by a simple instrument called Sphygmomanometer is from 110/60 to 120/80 mmHg (the first figure is systolic and the 2nd figure is diastolic). When the pressure goes above the 140/90 mmHg and remains elevated a hypertensive (high blood pressure) condition definitely exists. The systolic pressure tends to rise with age as arteries constrict and lose their elasticity. But it is the diastolic pressure that determines the severity of hypertension. It is also known primary or essential hypertension or silent killer as no apparent symptoms appear until it is well advanced. Contrary to popular believe headache is not a common symptom of hypertension.

Among the most contributory factors are obesity, diabetes, excessive salt intake, smoking and emotional stress and family history of high blood pressure. Smoking increases the chance of heart attack because it raises the blood pressure. A single cigarette smoking can also increase 10 to 15 mmHg blood pressure for a temporary period.

Depending on the diastolic blood pressure hypertension is graded mild between 90-110 mmHg, moderate between 110-130 mmHg and severe over 130 mmHg. The higher the pressure the greater is the strain on the heart and the more devastating effect on vital organs. The kidneys eventually fail to excrete enough fluids and toxic substances. Urea accumulates in the blood causing uraemia - a fatal complication may result.

Another kind of hypertension is known as secondary hypertension, which has an organic cause - obstructive kidney disease, tumors of the brain, thyroid or adrenal glands or narrowing of the aorta. It is more common in young persons and surgery usually restores the normal pressure levels.

High blood pressure roughens the artery walls. This allows fatty substances, cholesterol, triglyceride and phospholipids to accumulate under their inner linings. The result is atherosclerosis or thickening of the walls of the arteries, which prevents blood from flowing easily and may lead to clotting. These clot formations can suddenly choke off the blood supply and lead to a heart attack, cerebral stroke or kidney failure. Hypertensives are five times more likely to suffer stroke than the persons with normal pressures.

Now-a-days lipid profile specially the ratio of High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL) is more important for diagnosis of atherosclerosis. LDL rich in cholestetaryl esters transport cholesterol from hepatic cells to extrahepatic cells causing atherosclerosis. Whereas HDL transports cholesterol and esters from peripheral tissues to the liver where cholesterol would be metabolised as a result atherosclerosis condition would be decreased.

Following measures should be taken to reduce the high blood pressure :-

i) Body weighht should be controlled with proper diet and regular exercise.

ii) Intake of salt and fatty foods should be limited.

iii) Blood pressure must be checked annually or every six months if there is a history of hypertension.

iv) Stress, anxiety, worries and anger should be minimised.

I conclude saying be wise and get your blood pressure checked soon.

Selected References

Guyton, A.C. and Hau, J.E. (1996). Textbook of Medical Physiology, 9th edn, Prism Books (Pvt) Ltd, Bangalore.

Ganong, W.F. (1995). Review of Medical Physiology. 18th Edn, Printice-Hall International Inc., New Delhi.

Murray, R.K. *et al.* (1996). Harper's Biochemistry, 24th Edn, Appleton & Lange, Connecticut.

□

MAMMALIAN CELL CULTURE : A BRIEF OUTLINE

Swadesh Duttagupta
Indian Institute Chemical Biology,
4, Raja S.C. Mullick Road, Calcutta - 700 032

Introduction

Since the earliest days of experimental cancer research, attempts have been constantly made to study the disease by cultivating normal and cancerous cells and tissues outside the organism. Tissue culture began in 1907 when Harrison notices that nervous tissue explanted from frog embryo into dishes of frog lymph developed axonal processes In 1912, at about the same time when Rous found a filterable avian sacroma virus, Alexis Carrel was able to grow bits of chick heart *in vitro* by putting them into drops of horse plasma.

Long Term Culture

Carrel was the first to show that explants of chick heart could be kept alive and growing over extended periods if they were fed and subdivided regularly. In contrast, a chick embryo must be well fed by its own fluid i.e. aqueous extract of whole chick embryo and found that the cultured tissue would remain alive indefinitely. During this period all attempts to grow cultures from single cell failed primarily due to nonavailability of any antibiotics to check contamination problem. In 1948, Earle *et al.* first reported that they were able to grow single cells derived from carcinogen treated explants, completely isolated from other cells.

Primary and Secondary Cultures

Cells that grew out from an explant in a suitable medium are called primary cultures. Any cultures that are derived from primary ones are called secondary cultures.

Various Cell Cloning Procedures

These include microcapillary tube method, use of feeder layer, use of sterile cylinder, serial dilution method using microwell plates etc. These procedures and their applications in biological studies will be discussed in detail.

Development of Partially Defined Culture Media

The need for synthetic medium was felt by Earle and other workers as early as 1948. Many of the defined media that are used to day stem from the work of Eagle when it was observed in 1950's that penicillin and streptomycin are harmless to cells in culture. Eagle in 1955 first develop the optimal cell culture medium which is still in use as Basal Medium Eagle or in short BME. Basic ingredients of BME,includes 13 essential amino acids, mixture of vitamins, salts, glucose and 5-10% whole horse or human serum. Now fully defined tissue culture media completely devoid of serum/plasma are available commercially whichcontain various growth factors for growing specific cell lines.

Embryonic Origin of Cell Types

During earliest stages of development of all vertebrate embryos, all cells are strikingly similar. The earliest sheet of cells comonly known as bastula tuck into each other producing a two-cell layer thick dome called gastrula. The dome cells then migrate and form tubules between outer and inner layer. These three primitive layers called ectoderm, endoderm and mesoderm then differentiate to give rise to the various tissues and organs of the animals.

Establishment of "Normal" Cell Lines

In late 1950's, it was apparent that many "normal" cultivated cells have spontaneously acquired the ability to form tumours *in vivo*. By 1958, Puck *et al.* had succeeded in cultivating normal fibroblasts from tissues of Chinese hamsters. In 1961, Stoker & Macpherson established BHK 21 cell line from polyoma virus transformed Syrian baby hamster kidney cells. In 1963, Todaro and Green established the 3T3 cell line, the first mouse fibroblast cell line which was not spontaneously transformed. Almost all cultivated "normal" cells appeared to be of mesoderm origin. Establishment of other cell lines of different species including human will be dicussed.

Characteristics of Transformed Cells

These cells can grow in solid medium or in suspension, have low serum requirements, are contact inhibited and in many ways quite different from normal cells.

Cell Synchronisation

Several methods are employed for cell synthronisation that includes, a) Self-Synchronisation,

b) Drug Synchronisation, c) Synchronisation by Physical Separation and other techniques. Each procedure has its specific use and advantages.

Chromosome & Ploidy

The amount of DNA does not vary greatly from species to species among mammals, ranging from 5-7 pg/cells. However, the number of chromosomes and their shapes differ greatly from species to species. The somatic cells of eukaryotes contain sets of pairs of chromosomes and therefore are diploid. Sperm and ova (the gametes) by contrast have only one copy of each chromosome and are said to be haploid. If maternal and paternal chromosomes including both sex chromosomes, are all identical in number and shape to a standard set called "karyotype" of the species, then cells are said to be "euploid". Most cultivated cells have a median chromosome number, three to four times the haploid number of their species. For instance 3T3 cells have about 70 chromosomes instead of 46 (23 pairs) present in normal mouse cells. Abnormal cells are "aneuploid" if it contain wrong number of chromosomes and "heteroploid" if the chromosome number varies from cell to cell.

***In vitro* Selection of Mutants**

Various methods for selection of mutant cells include Negative Selection, Auxotroph Selection, Drug Selection and HAT Selection. These procedures will be discussed in detail.

Hybrids of Mammalian Cells

The procedures for hybridisation of somatic cells of different species, selection of hybrid cells and their application in genetic and other studies will be discussed briefly.

Selected References

Karow, A.M. and Critser, J.K. (1997). Reproductive tissue Biology, Academic Press, London.

□

EMERGING ENTERIC PARASITES OF HUMAN

Pradeep Das

National Institute of Cholera and Enteric Diseases,

P-33, C.I.T. Road, Scheme XM, Beliaghata, Calcutta - 700 010

Diarrhoeal diseases represent one of the important causes of morbidity and mortality particularly in children below five years of age in the developing countries. The disease is caused by bacteria, virus or parasites. Amongst the parasites, *E. histolytica*, *G. lamblia*, *Cryptosporidium spp*, *Microsporidia spp*, *Cyclospora caytenansis* and *Isospora belli* are considered to be the major ones. Excluding *E. histolytica* and *Giardia* others are recently recognized coccidian parasites responsible for acute diarrhoea in immunocompromised host particularly, in AIDS patients. Salient features of newly recognized parasites and the disease caused by them is discussed.

Cryptosporidium

Cryptosporidium is a parasite which causes self limiting diarrhoea in immunocompetent persons and severe life threatening disease in immunocompromised individuals, particularly, to patients suffering from acquired immunodeficiency syndrome (AIDS). Because of increased incidence of HIV (Human immunodeficiency virus), the protozoan parasite has found human host as an ideal one, to perpetuate and propagate, resulting in a natural amplification of this parasite. Much less is known about *Cryptosporidium* in India, although, it is clear that this parasite is going to be a major enteric pathogen in coming years, considering the increasing number of HIV cases that are being reported in this country.

The first description about the parasite resembling to be *Cryptosporidium* was revealed by Clark in 1895. However, the detailed description about the parasite was reported by Tyzzer in 1907. He offered the name *Cryptosporidium muris*, but was not able to provide the characteristics for establishing the new genera until 1910. The first case of human Cryptosporidiosis was reported in 1976. Since then *Cryptosporidium* has been detected as one of the major diarrhoeagenic pathogen in humans throughout the world. A rough estimate suggests that about 250 to 500 million individuals are infected annually by *Cryptosporidium spp.* in Europe, Asia, Africa and Latin America. The prevalence of infection varies widely, but it appears to be highest amongst young children and AIDS patients. Studies on childhood diarrhoea in developing countries reported an average prevalence rate of 8.3% for *Cryptosporidium*. The disease is acquired by ingestion of oocyst in contaminated water, by contact with infected animals, and by person to person transmission. The intensity of infection is found always higher in AIDS patients than the

immunocompetent persons. In immunocompetent host, illness is self limited, however, in patients with advance immunosuppression, infection may result in a prolonged life threatening Cholera like diarrhoea. There is no effective drug therapy or preventive vaccine available. Mechanism of immunity to *Cryptosporidium* is not well understood. However, studies from mice selectively depleted of CD4+ (helper) T lymphocyte as well as AIDS patients, especially those with CD4+ cell counts 200/ mm^3 or fewer were found at special risk for *Cryptosporidium* infection. The infection in this population is chronic, progressive and sometimes fatal. The parasite once thought, rare and host specific, is now known to be ubiquitous and have multiple hosts. Although, recognized and named in 1907, most information on parasite's life cycle, clinical significance, epidemiology and treatment have accumulated during the past few years.

According to recent classification, all the members of *Cryptosporidium* belong to a single family, Cryptosporidiidae. The life cycle of *Cryptosporidium spp.* is monoxenous type (requires a single host to complete the life cycle). *Cryptosporidium* have been detected in pharynx, oesophagus, stomach, duodenum, jejunum, ileum, appendix, colon, rectum, gall bladder and respiratory tract of human, although the jejunum is found to be most heavily infected site. The real Koch's postulates has not been clearly established in human cryptosporidiosis and some doubt remains as to whether *Cryptosporidium* is an agent of clinical disease or whether it is an opportunistic pathogen. Empirical evidences however, suggest that *Cryptosporidium* is an agent of diarrhoea. In a recent study on AIDS patients infected with *Cryptosporidium* it is observed that flattening of villi, mainly rely on the intensity of infection. The exact mechanism by which *Cryptosporidium spp.* causes the disease is not known. Some of the mechanisms which are currently postulated are : i) parasite induced damage of intestinal architecture leading to malabsorption and producing osmotic diarrhoea, ii) the release of metabolites of inflammatory or hormonal nature (or both) as a part of the host response to the infection, which in turn, may induce intestinal secretion possibly associated with malabsorption and production of an enterotoxic moiety by the parasite responsible for secretory diarrhoea, iii) the role proposed by the tumor necrosis factor a by changing the porcine intestinal ion through a paracrine mechanism to stimulate the prostaglandin (E_2) for diarrhoea.

Presence of anti-*Cryptosporidium* IgM, IgG and IgA antibodies in sera of both immuno competent and immunocompromised patients infected with *Cryptosporidium* have been demonstrated, an observation which suggest that antibodies play no role in host protection against cryptosporidiosis. However, feeding of bovine colostrum (containing anti-*Cryptosporidium* antibodies) to infected humans showed, rapid clearance of *C. parvum* oocyst. Similarly, feeding of colostrum or purified anti *C. parvum* antibodies, monoclonal antibodies to sporozoite or polyclonal antibodies against surface sporozoite antigens common to merozoite have demonstrated partial protection *in vitro* and *in vivo* experiments against *Cryptosporidium* infection.

Identification of *Cryptosporidium* in stool samples was first accomplished in 1978 for calves and in 1980 for humans. The most widely used staining procedure is modified acid fast which

differentiates red stained oocyst from similarly sized and shaped blue stained yeast.

The true incidence of cryptosporidiosis is not known. A recent survey estimates that the parasite could be recovered from 1 to 20% of immunocompetent diarrhoeal patients. However, in AIDS cases the disease was reported from 10 to 50% of AIDS patients. In India, so far, very few studies have been conducted and the parasite was detected from 3% of cases from the north, 5.5% from east and 13% from the south Indian population.

Till date more than 90 drugs have been tried but none of them has been found completely active against symptomatic cryptosporidiosis. Development of a new effective therapeutic agent has been limited due to lack of, *in vitro* cultivation of parasite which could help in understanding the biochemical and metabolic requirements of *Cryptosporidium spp.* Studies are also hampered by the lack of a suitable small animal model for screening efficacy of a drug.

Microsporidia

Microsporidians are unicellular, obligate, intracellular parasite. Although eukaryotic but devoid of mitochondria, possess ribosomes similar to prokaryotes. The first case of intestinal microsporidiosis was reported from a HIV-infected patients in 1985. Five genera of microsporidia were found to produce diseases in human but *Enterocytozoon bieneusi* is the most common among HIV-infected patients. In light microscope, microsporidian spores showed bilayered spore wall consisting of an outer electron-dense layer and an inner electron-lucent layer. The most common diagnostic methods are staining of stool samples by Weber's modified trichrome stain or fluorescence staining with Calcofluor White. In fluorescence staining microsporidian spores become greenish-white. About 15 to 70% infection has been reported in AIDS patients from studies at Australia, USA, Netherlands and England.. In several studies of Africa 3 to 8% of infection was recorded in immuno-compromised patients.

The clinical features in HIV patients with *Enterocytozoon bieneusi* infection showed abdominal pain and sinusitis, an average of 5 kg weight loss in each person, 4 stools per day and diarrhoea persists for 4 months. The mean CD_4 count was 15/mm^3.

Cyclospora

Cyclospora were first described by Eimer in 1870 in the intestine of moles. However, the first report of human cyclosporiasis came in 1979 from Papua New Guinea. Detection of *Cyclospora* oocyst is mainly done by modified Ziehl Neelsen staining. Oocysts are 8 to 10 µm in diameter. The parasite has been reported throughout the world from both resident and travellers. However, it is endemic insome countries like Nepal, Haiti and Peru. The studies conducted showed 11% prevalence rate among non-native adults and children residing in Kathmandu, 5% among the symptomatic children and 2% in asymptomatic children. However, 18% and 6% of infection among 1 month to 2 years old children were reported from Peru. A 11% infection was observed in HIV-

infected Haitian adults. Several water-borne outbreaks have been reported due to *Cyclospora*. In 1990 outbreak which involved 20 individuals in Chicago hospital, most of them were resident physicians, epidemiological evidence suggest that water from roof top reservoir was responsible for infection. *Cyclospora* has been detected as one of the commonest cause of traveller's diarrhoea and prevalent in Indian sub-continent. The main clinical features recorded in these patients were watery and yellow stool, anorexia, abdominal pain, weight loss (3 to 15 kg) and weakness.

Isospora

Isospora is a host specific coccidian protozoan parasite (phylum-Apicomplexa). It was first described by Virchow in 1860. Wenyon described it as a human pathogen in 1915. In 1984, *Isospora belli* was first established as a causative agent of opportunistic infection in patients with AIDS (Whiteside *et al.*, 1984). Recent reports revealed that 5 to 20% of the AIDS patients carry this parasite throughout the world. Immature oocysts of *I. belli* are ellipsoid or spindle shaped with blunt ends and contain two sporocysts. Each sporocyst contain 4 curved sausage shaped sporozoites.

I. belli infections are essentially cosmopolitan in distribution but are more common in tropical and subtropical regions especially Haiti, Mexico, Brazil, El Salvador, tropical Africa, the Middle East and South-east Asia. In India, 5 to 12% isosporiasis was reported in AIDS patients. *I. belli* presents self-limiting diarrhoea in normal hosts, while in AIDS, the diarrhoea is chronic and protracted. Symptoms of *I. belli* infections in immunocompetent patients include diarrhoea, steatorrhea, headache, fever, malaise, abdominal pain, vomitting, dehydration and weight loss. Blood is not usually present in the feces. In immuno-compromised hosts, *I. belli* presents with chronic intermittent diarrhoea, fat and Vit. B_{12} malabsorption as well as lactose intolerance.

Selected References

Soave, R. (1996). *Cyclospora* : An overview. Clin. Infect. Dis. **23** : 429-437.

Chioralia, G. *et al.* (1998). Relevant criteria for detecting Microsporidia in stool specimens. J. Clin. Microbiol. **36** : 2279-2283.

Lindsay, D.S., Dubey, J.P. and Blagburn, B.L. (1997). Biology of *Isospora* spp. from humans, non-human primates, and domestic animals. Clin. Microbiol. Rev. **10** : 19-34.

Das, P. (1996). *Cryptosporidium* related diarrhoea. Ind. J. Med. Res. **104** : 86-95.

Manabe, Y.C. *et al.* (1998). Cryptosopridiosis in patients with AIDS : Correlates of Disease and Survival. Clin. Infect. Dis. **27** : 536-542.

MANAGEMENT OF ACUTE DIARRHOEA

S.K. Bhattacharya, *Director*
National Institute of Cholera and Enteric Diseases
P-33, CIT Road, Scheme XM, Beliaghata, Calcutta - 700 010

Acute diarrhoeal diseases are an important cause of morbidity and mortality particularly in children in the developing world. In 1993, an estimated 3.2 million children below the age of 5 years died from diarrhoea alone; 80% of these deaths occur in those who are below 2 years of age. Diarrhoea is also an important contributor of maluntrition.

Based on the pathogenic mechanisms of production of diarrhoea, diarrhoeagenic organisms may also broadly be divided into two groups, viz., secretory and invasive. The secretory group of organisms, the prototype of which are *V. cholerae* O1 or O139 and Enterotoxigenic *E. coli*, produce one or more toxin(s), which may be heat-labile (LT) or heat-stable (ST) or both. The toxin(s) liberated into the gut lumen excite(s) a series of bichemical changes, ultimately resulting in accumulation of cyclic AMP inside the cell and as a result there is outpouring of large amount of fluid rich in electrolytes (e.g., Na^+, K^+, Cl^- and HCO_3^-). If there is sufficient loss of fluid and electrolytes from the body, the net result is the appearance of certain signs and symptoms collectively known as "dehydration". The secretory organisms usually do not produce structural changes in the gut mucosa and the diarrhoea they produce is 'watery' in nature. Hence, the treatment of these cases of acute watery diarrhoea is one of replacement of fluid and electrolyte losses. On the other hand, invasive organisms, the prototype of which is *Shigella*, invade the gut mucosa and produce an inflammatory reaction and as a result there is outpouring of blood and mucous along with loose stools. The amount of fluid loss in these cases is usually minimal and hence dehydration is not a conspicuous feature. The stools in these cases are mixed with blood and mucous which is known as 'dysentery'. As they produce ulcers in the gut mucosa, antibiotics play very vital role in their management.

Management of diarrhoea essentially consists of (i) accurate assessment of degree of dehydration; (ii) identification of associated problems; (iii) institution of appropriate rehydration therapy; (iv) use of appropriate antibiotics in selected patients and (v) feeding during diarrhoea.

Assessment of degree of dehydration

Dehydration can be classified into three categories, namely, mild, noderate and severe. However, recently WHO recommended that dehydration should be classified as "diarrhhoea with no dehydration" and "diarrhoea with dehydration". The latter can be subclassified into diarrhoea with "some" dehydration, diarrhoea with "severe" dehydration. The "some" dehydration includes mild and moderate dehydration of the previous classification.

Identification of associated problems

While assessing the degree of dehydration, it is also important to identify (a) whether there is blood in the stool; (b) is it a case of persistent diarrhoea; (c) is diarrhoea associated with malnutition and (d) whether non-intestinal infection e.g. pneumonia, otitis media, fever, falciparum malaria etc. are also present.

Institution of appropriate rehydration therapy

Treatment with diarrhoea with some dehydration in 95% of cases can be done with oral rehydration therapy.

Oral rehydration therapy (ORT)

WHO recommended ORS has the following composition : Sodium chloride (3.5 g), sodium bicarbonate (2.5 g) or trisodium citrate, dihydrate (2.9 g), potassium chloride (1.5 g), glucose (20 g); and water (1 litre).

The above solution has a total osmolality of 331 or 311 depending upon bicarbonate or citrate used in the preparation of the ORS (Sodium 90 mmol/l, Potassium 20 mmol/l, Chloride 80 mmol/l, bicarbonate 30 mmol/l or citrate 10 mmol/l, and glucose 111 mmol/l).

Intravenous therapy

Intravenous administration of fluid and electrolytes is indicated for correction of severe dehydration in children as well as in adults. The preferred solution in Ringer's Lactate.

Role of antibiotics in the treatment of diarrhoeal diseases

Antibiotic treatment has been shown to be beneficial for the treatment of cholera and shigellosis only.. For cholera, it has been documented that use of appropriate antibiotic in conjunction with rehydration therapy shortens the duration of diarrhoea, fluid loss in the stool and excretion of *Vibrios* in the stool. Doxycycline 300 mg (single dose) or tetracycline 500 mg 4 times daily for 3 days for adults or 12.5 mg/kg 4 times daily for 3 days for children are useful drugs. Recently, it has been shown that multiple doses of norfloxacin is an effective alternative for both O1 and O139 cholera and may be particularly useful in situations where resistance to tetracycline, co-trimoxazole or furazolidone has been encountered.

Numerous clinical trials have documented the beneficial effeccts of appropriate antibiotic therapy in the treatment of shigellosis. Such treatment shortens the duration of diarrhoea and excretion of *Shigella* in stool. Nalidixic acid is the drug of choice. Norfloxacin may be used for adults.

Feeding during diarrhoea

Feeding appropriately during diarrhoea is well tolerated and hastens recovery as well as prevents malnutrition. Hence, there is no need to rest the bowel during diarrhoea. Energy dense, potassium containing, non-fibrous food should be given to all children with diarrhoea. An extra feed should be given daily for 2 weeks during convalensce.

Selected References

Bhattacharya, S.K. (1996). Management of acute Diarrhoea. Ind. J. Med. Res. **104** : 96-102.
W.H.O. (1992). Management of the patient with cholera. WHO/CDD/SER/91. 15 REv 1, 1-8.
W.H.O. (1992). Guidelines for cholera control. WHO/CDD/SER/80.4 Rev 4. 1-39.
W.H.O. (1990). A manual for the treatment of diarrhoea. WHO/CDD/SER/80.2 Rev 2.

□

CURRENT UNDERSTANDING IN THE GENESIS AND TREATMENT OF HUMAN LEUKEMIAS AND LYMPHOMAS

Manas Ranjan Ray

Experimental Hematology Unit, Chittaranjan National Cancer Institute
37, S.P. Mukherjee Road, Calcutta - 700 026

Leukemia, or 'blood cancer' to the common people, is a malignant disease of the blood-forming cells in the bone marrow. Lymphoma, on the other hand, denotes malignancy in lymphoid cells or tissues. These two hematological malignancies are encountered in all age groups and account for death of several lakhs of people throughout the world annually.

Leukemia type and incidence

Leukemias are broadly classified into four groups on the basis of type, maturation and number of leukemic cells in peripheral blood : Acute lymphoblastic leukemia (ALL), Acute myeloid leukemia (AML), Chronic myeloid leukemia (CML) and chronic lymphocytic leukemia (CLL). ALL is the most common malignancy in children, with a peak at 4-10 years. About 4000 new cases are diagnosed each year in the United States. The corresponding number of AML cases being 9000

per year. But AML is more frequent in older people with a median age of diagnosis being 65 years. Similarly, CML and CLL are more frequently diagnosed at the age group of 50-60 years. In India, CML is predominant over CLL and AML. Lymphomas, on the other hand, are subdivided into Hodgkin's and Non-Hodgkin's lymphoma, diagnosis of the former is established by the presence of binucleated Reed-Strenberg cells.

Diagnosis

Diagnosis of leukemias are made on the basis of investigations of blood and bone marrow cellularity and cytochemistry. Upto 92% leukemic lymphoblasts are found in peripheral blood in ALL whereas leukemic myeloblast, monoblast, erythro- and megakaryoblasts are found in abundance in AML patients' circulation. CML cases are usually diagnosed by the presence of philadelphia (Ph^1) chromosome [$t(9:22)(q^{34}q^{11}$], while absolute peripheral lymphocytosis (>20,000/ µl) comprising functionally abnormal leukemic lymphocytes indicates CLL.

The common complications are fatigue, malaise, dyspnea, weight loss, bone pain, unexplained fever, anemia, pallor, hepato-splenomegaly, lump in neck nonresponsive to antibiotics (Hodgkin), gum or skin infiltration.

Etiology

Leukemias and lymphomas inmajority of cases arise de novo. But some causative factors have also been identified : i) genetic predisposition viz. Down's syndrome and Klinefelter's syndrome; ii) radiation is implicated in the 30-fold increase in AML and CML cases in atom bomb survivors in Hiroshima. In Nagasaki, where exposure to γ-IR was higher, incidence of AML was even greater. Children born after Chernobyl disaster also showed high incidence of leukemias; iii) certain chemicals like benzene and other petroleum products, several inticancer agents and drugs like chloramphenicol, phenylbutazone etc. are leukemogenic; iv) about 20% of AML are attributed to smoking.

Investigations into the molecular mechanism of human leukemias have revealed involvement of some specific genetic alterations. For instance, mutation of N-ras protooncogene at codon 12, 16 and 61 in AML, Ph^1 chromosome and fusion of bcr/abl fusion gene and its products p^{210} in CML and p^{190} in ALL; t(15:17) and fusion gene product RARα-PML in M3 AML and abnormal expressions of PAX-5, BCL-1,2,6 and C-myc oncogenes in Non-Hodgkins lymphoma.

Treatment and outcome

Besides treatment with conventional chemotherapeutic drugs like hydroxyurea, cyclophosphamide, adriamycin, Ara-C and vinca alkaloids, biological response modifiers such as interferons and interleukins are increasingly being used with considerable success. Extended field radiotherapy is also applied for the treatment of lymphomas. In addition, calcium channel

blockers like verapamil are used to counteract MDR-1 mediated drug resistance of leukemic cells. Another very fascinating field of treatment of hematologic malignancies is bone marrow transplantation which can achieve 'cure' for upto 60-70% of patients particularly at younger age group. As a result of these advancements, a cure rate of as high as 90% has been achieved in childhood ALL and Hodgkin's lymphoma. Unfortunately, the prognosis of other forms of leukemias and lymphomas is relatively poor. Intense multidisciplinary research is now focussed on the mechanism and treatment of refractory forms of the disease and a breakthrough is expected in not so distant future.

Selected References

Hoffman, R., Benz Jr. E.J., Shattil, S.J., Furie, B., Cohen, H.J. and Silberstein, M. (1995). Hematology : Basic Principles and Practice, 2nd Ed. Churchil-Livingstone, New York.

Glover, D.M. and Hames, B.D. (eds) (1989). IRL Press, Oxford.

Hayhoe, F.G.J. and Quaglino, D. (1994). Hematological cytochemistry. Churchill-Livingstone. 3 J Edn. Edinburgh, London.

□

OVULATION — INDUCTION AND SUPPRESSION

S.P. Bhattacharyya

Department of Zoology, University of Kalyani, Kalyani 741235, W.Bengal

The ovaries are the source of ova and reproductive hormones that regulate the female sexual life. The two functions namely, generation of ova and secretion of hormones are closely integrated. Selection of a single follicle, its dominance over other follicles, its rapid growth and commitment for release from the ovary (ovulation) are accomplished through a series of sequential events dictated and regulated by several factors produced by the ovary and the hypothalamo-hypophysial unit.

The impetus for resumption of growth and development of a primary follicle to the mature one is derived primarily from FSH and LH of anterior pituitary. Estradiol, produced largely from

granulosa cells of the follicles, can to some extent stimulate follicular growth *per se* independently and can also act permissively with FSH.

The hormones play a crucial role in causing ovulation. 'LH surge', which occurs about 10-12 hr prior to ovulation, is considered to be a relatively precise predictor of the time of ovulation. In women it is difficult to pin-point the exact time ovulation, since ovulation takes place at the middle of menstrual cycle. However, record of basal body temperature, change in the physical nature of cervical mucus, plasma estradiol pattern and the plasma profile of LH give some indication about the time of the onset of ovulation.

. The 'mid-cycle LH surge' is a consequence of the positive-feedback action of circulatory estrogen, operative at both hypophysial and hypothalamus levels. The principal hypothalamic factor that stimulates release of LH is a decapeptide (MW, 1182) — the LH releasing hormone (LHRH) or gonadotropin releasing hormone (GnRH). The current predominant view is that LHRH is the only hormone that regulates the release of both FSH and LH. Pulsalile secretion of LHRH is a pre-requisite for gonadotropin release and ovulation. Progesterone is reportedly responsible for FSH surge.

The initial step involved in the action of LHRH on gonadotrops is its binding to high affinity receptors of plasma membrane and activation of phospholipase C and protein kinase C resulting in increase in cellular calcium, while action of LH and FSH on the granulosa cells is exerted primarily through increase of intracellular cAMP (also phospholipase C) and subsequent activation of several proteins including the steroidogenic enzymes.

Hypothalamic secretion of LHRH is influenced also by the neurons from other regions and other centers of the brain. The precise way how it is effected is not clear. Mating-induced ovulation in reflex ovulators as well as the findings from some excellent studies performed long ago on the effects of antiadrenergic, anticholinergic agents, barbiturates and narcotics in preventing or delaying ovulation in adult rats and in PMSG-induced immature ones clearly indicate the involvement of neural signals in triggering LHRH release.

Exact mechanism of follicular rupture is not known. The process is complex and is accomplished by coordinated actions ovarian and hypophysial hormones as well as by a cohort activity of locally active substances including some growth factors, prostaglandins, plasminogens, collagenolytic substances etc.

Ovulation can be induced in some clinical cases. Of the drugs used for this purpose, clomiphene — a nonsteroidal compound with rather low antiestrogenicity — is frequently applied in women having otherwise normal estrogen producing capacity and ovarian sensitivity to gonadotrophins. The drug acts by binding to estrogen receptors in hypothalamus, blocking the negative feedback of estrogen at these sites and thus inducing rise of FSH and LH. Bromocriptine is a dopamine antagonist that inhibits secretion of prolactin in the patients with elevated PRL and in women with pituitary prolactinoma. However, its application should be done after thorough

endocrine work of the individual. The hormones hMG and hCG are used for women who fail to ovulate while taking clomiphene citrate and for women with hypogonadotropic hypogonadism. LHRH preparation administered in pulses of 90-120 minutes intervals for 10-20 days has been successful in inducing ovulation in hypogonadotropic women. Such treatment promotes growth of single folicles and causes about 90% ovulation with less side effects.

The success of experiments in the inhibition of ovulation after administration of estrogen extract and progesterone stimulated researches in the application of these agents in contraception and fertility control. Oral, injectable and implantable contraceptives are now in most widely used preparations for family planning and fertility control. These are different formulations of synthetic progestrogens alone or of estrogen - progestogen combination. All progestins are 19-nor testosterone (and 17α-ethinyl) derivatives having progestational potency and very low androgenicity. Combined preparations disrupts the mid-cycle LH surge by their action at hypothalamic and hypophysial loci. Basal levels of LH and FSH are also reduced. These contraceptive compounds also exert their effects on sperm transport in females and change the character of cervical mucus leading to interference in fertilization. Continued use of contraceptives however develops some unwanted side effects, such as, increase of cholesterol, LDL, small hypertension, amenorrhea, ischemic heart disease, thromboembolism etc. There have been several studies to assess the side effects and the magnitude of risk attached to them. This is a global issue and, as such, needs more studies. The problems and the magnitude of side effects seem to be correlated with age, nutrition, habit and lifestyle of the users.

Selected References

Knobil, E. & Neil, J.D. (Eds.) (1994). The Physiology of Reproduction. Lippinocott - Raven Publ.

Gougeon, A. (1996). Regulation of ovarion follicular development in primates. *Endocrin. Rev.* **17** : 121.

Adash, E.Y. & Leung, P.C.K. (1993). The Ovary. Lippincott - Raven Publishers.

Hatcher, R.A., Rinert, W., Blackburn, R. & Geller, J.S. (1997). The Essentials of Contraceptive Technology. John Hopkins Population Program; WHO.

Carr, B.R. (1998). Disorders of the ovaries and female reproductive tract. *In* Williams Text Book of Endocrinology (9th edn). W.B. Saunders & Co. Philadelphia, Toronto, London, Singapore, Tokyo. p.753.

Carr, B.R. & Griffin, J.E. (1998). Fertility control and its complications. *In* Williams Text Book of Endocrinology (9th edn). W.B. Saunders & Co. Philadelphia, Toronto, London, Singapore, Tokyo. p. 901.

□

WETLAND RESOURCES FOR HUMAN SUSTENANCE : A CASE STUDY FROM WEST BENGAL

Subir K. Ghosh

Member, Wetland Sub Committee, WWF-INDIA (Eastern Region)

Introduction

Values of wetlands and its resources to manking need no further mention, Traditional use of wetland resources is age old and due to coexistance of man an wetland and also for their intimate dependence, wetland resources have been integrated with the social and cultural values of wetland dwellers. Apart from conventional resources like paddy, jute, fish, prawn, crabs, molluscs etc. a significant number of wetland plants having human utility and so also commercial potentialities, can be considered as non-conventional resources of wetland eco-system. Although most of these crops, grow in wetlands, can be regarded as subsistence crop, still they are important to a section of rural communities who otherwise manage their livelihood support partially from it.

It may be useful to briefly recapitulate to wetland resource base in India. Wetlands harbour a rich gene-pool of both conventional and non-conventional resources. Wetlands of fresh water habitat covers only less that 6% of the earth surface but support nearly 20% of the Earth's biodiversity (MITSCH and GOSSELINK, 1986). A recent endeavour by C.D.K. COOK (1996) reveals that number of wetland vascular plant species in permanent or seasonal fresh water in the subcontinent of India (South of the Himalayas) is nearly 733 belongs to 211 genera and 66 families. This resource is probably more higher (likely to be 1200 to 1500) i.e. about 10% of all higher plants in India according to Cook's pers. comm. with Brij Gopal (Gopal, 1997). Among the non-vascular cryptogams in wetlands, diversity of algae posed to be higher (more than 40% of the total Indian flora). Nearly 12% of the vascular cryptogams of India occurs in fresh water environment (see Gopal, 1997). In West Bengal, nearly 382 aquatic and wetland vascular plant species including mangrove and mangrove associates is known to occur in wetland habitat (Ghosh, 1998). All these plant resources are significant as primary producers of trophic level of the wetland eco-systems. Besides, wetland plants both living and their debries are significant to carbon-di-oxide and methane balance of the environs and thus maintain green house equilibria (Denny, 1985). Wetland plants having floating or emergent leaves are considered to be an impc tant tool to reduce global temperature rise.

Present Uses : * Major Wetland Resources
* Minor Wetland Resources

Major Wetland Resources

Major plant resources harvested from wetland for socio-economic benefits are as follows :

Mat

From traditional practice mat cultivation has been commercialized in otherwise less commercially viable wetlands of Medinipur and 24 Parganas (North). Mat plants also cultivated for commercial purpose in wetlands of Orissa and Madras. Commercial mat is obtained from culms of *Cyperus pangorei* and *Cyperus corymbosus*. Although a second quality mat is also prepared from *Cyperus exaltatus*, *Cyperus iria* and *Cyperus malaccensis*. Madur Kathi plants, once established, yield a crop of culm for at least three to five years and the culms are usually harvested twice a year. Several lacs of rural people are dependent on mat industry at different levels. It has been estimated that net profit earned from mat cultivation is Rs.90,000/- to Rs.1,05,000/- per ha per year. Major trade centres of mat are Sabang in Medinipur and Swarupnagar in 24 Parganas (North). Nearly 1500 ha area in Medinipur district and another 500 ha in 24 Parganas (North), presently exploited for mat cultivation. Per day per head income from mat cultivation varies from Rs.35/- to Rs.40/- during peak season.

Hogla

Commercial cultivation and management of cattails, locally called hogla-pati is more than a century old practice in the wetlands of lower Bengal. Dried hogla leaves are harvested for making of a coarse quality of mat, rain-shed, rain-hats. More than 20,000 rural people of Bengal are engaged in cultivation and management of hogla. Commercial hogla-pati is obtained from *Typha elephantina* and *Typha domingensis*. Net profi earned from management of hogla-cultivation is about Rs.5,000/- to Rs.9,000/- per ha per year. Presently demand of hogla leaves are gradually raising in decorating business. *Typha* swamp also exhibit bio-diversity of associated flora and fauna. So for ecological restoration and for transformation of low lying non-productive wetlands, the values of hogla cultivation is not negligible.

Shola

Commercial shola utilised for making ornamental products is obtained from the soft stem-pith of *Aeschynomene aspera*. Commercial shola cultivation is restricted to wetlands of 24 Parganas (North and South). Shola art is a family tradition of rural communities of Maheshpur village (Mathurapur P.S.) of 24 Parganas (South) for not less than 300 years. More than 20,000 people in South Bengal are engaged presently in different phases of shola cultivation and art making. Net profit earned from shola cultivation is estimated to the tune of Rs.40,000/- per ha per year. Export value of the same amount of products may earn additional 5-10 folds. For detailed economics of hogla, shola and mat cultivation see Ghosh and Santra (1997).

Makhana

Makhana (*Euryale ferox*) is an aquatic cash crop of North Bihar. According to a report of State Fishery Department, Govt. of Bihar, Patna (1990-91), more than 96,000 ha wetlands in the state are presently utilised for makhana cultivation. Edible makhana seeds are widely utilised for their rich nutrient resource and unique medicinal values. Although makhana was common in the jhills of West Bengal during the early part of the century but presently the plant gradually becomes rare. A very recent experiment done by the author in the R.K. Mission Campus, Narendrapur, 24 Parganas (South) to assess the possibilities of re-introduction of the plant in the wetlands of West Bengal revealed that makhana can grow well in local fish ponds. The experimental plants produced 30-35 fruits this year with standard seed weight. Moreover, propagules of makhana also successfully germinated this year in the experimental bed maintained in the author's terrace. Fried makhana seeds are selling in the Calcutta market at Rs.150/- per kg. Considering the tremendous commercial viabilities of makhana it is proposed that less productive wetlands can be transformed for makhana cultivation.

Paniphal

Traditional cultivation of paniphal (*Trapa natans* var *bispinosa*) is cultivated in wetlands of 24 Parganas, Hooghly, Howrah, Medinipur, Bankura, Birbhum and Malda. Benefit earned by local cultivators from paniphal cultivation is estimated about Rs.8,000/- to Rs.10,000/- per ha per year.

Minor Wetland Resources

Supplementary vegetables

Use of aquatic herbs as supplementary vegetables is more popular in North East India. Commercial exploitation of aquatic herbs in West Bengal is an age-old pratice (Majumder and Banerjee, 1976; Hazra *et al.*, 1996). Kalmi (*Ipomoea aquatica*) is much popular in the vegetable market. It is now also cultivated in some parts of South Bengal. Other aquatic herbs in this respect are kachu (*Colocasia esculenta*), hingche (*Enhydra fluctuans*), kulekhara (*Hygrophila schulii*), Dhenki shak (*Diplazium esculentum*), sushni (*Marsilea minuta*), bramhi (*Bacopa monnieri*), thankuni (*Hydrocotyle asiatica*), shaluk (*Nymphaea nouchali, N. pubescens*) and ban-hingche (*Alternanthera philoxeroides*). Several thousands of rural families in West Bengal, particularly women folks are engaged in harvesting and marketing of aquatic herbs.

Medicinal plants

More than 20 species grow widely in wetland habitat of North East India are harvested by the rural communities for medicinal use. Makhana, as mentioned earlier is most significant in this respect. In general, rhizomes of the genus *Nymphaea* and *Nelumbo* are exported for medicinal values. Tropical wetlands are rich resource of *Nymphaea* and *Nelumbo*. Presently, kesut (*Eclipta*

alba), thankuni kulekhara, sushni, bramhi, *Neptunia natans, Acorus calamus* are extensively marketed in the city markets for harbal medicure.

Aquarium plants

More than 6 wetland species are presently harvested from wetlands for supply to aquarium markets. *Vallisneria natans, Hydrilla verticillata, Aponogeton natans, Aponogeton undulatus, Hygrophila polysperma* and *Cabomba caroliniana* var. *caroliniana* are common aquarium plants harvested from the fresh water wetlands. *Cabomba* being an exotic species has been naturalised in India during the last few decades. Small scale cultivation of this species has been recorded from West Bengal.

In addition to this, several wetland species grow in tropical wetlands are capable of reducing nutrient loads of waste water.

Management need

Traditional practice of harvesting and management of non-conventional wetland resource is an unique example of wet land resource exploitation. Conservation of wetland resource is not always beneficial. Still this is practised in wetlands since long due to lack of positive alternatives. Following recommendations are suggested for future management of non-conventional wetland resources.

(i) Determination of area of cultivation/management of individual species.
(ii) Estimation of human population depending on individual resource.
(iii) Assessment of alternative development in wetlands strengthening stock upgrading.
(iv) Transformation of less productive wetlands by cultivation of commercially viable wetland species like makhana to ensure eco-system sustainability.
(v) Utilisation of scavenger plants for treatment of waste water where possible.
(vi) Preparation of users manual.

Selected References

Cook, C.D.K. (1996). Aquatic and Wetlands plants of India. Oxford University Press. pp. 385.

Denny, P. (1985). Wetland vegetation and association plant life-forms. In : The ecology and management of African wetland vegetation, P. Denny, ed. Dr. Junk Publishers : 1-18.

Ghosh, S.K. and Santra, S.C. (1997). Economic benefits of wetland vegetation for rural populations in West Bengal, India. In : Giesen, W. (ed.) 1997. Wetlands, Biodiversity and Development. Proceedings of Workshop 2 of the International Conference on Wetlands and Development held in Kuala Lumpur, Malaysia, 9-13 October 1995. Wetlands International, Kuala Lumpur, pp. 119-131.

Ghosh, S.K. (1998). A Pictorial Directory of Common Wetland and Aquatic plants of West Bengal.

Department of Environment, Government of West Bengal, India. 124 pp.

Gopal, B. (1997). Wetlands and Biodiversity : How to kill two birds with one stone? In : Giesen, W. (ed.) 1997. Wetlands, Biodiversity and Development. Proceedings of Workshop 2 of the International Conference on Wetlands and Development held in Kuala Lumpur, Malaysia, 9-13 October 1995. Wetlands International, Kuala Lumpur. pp. 18-28.

Hazra, P.K., Banerjee, L.K. and Roy, A. (1996). Thhe water-chestnut or singhara nut. Envis News Letter, Vol. 3, pp. 3-9. Botanical Survey of India, Calcutta.

Majumder, N.C. and Banerjee, R.N. (1976). The distribution and economic uses of *Alternanthera philoxeroides*. Bulletin of the Botanical Society of Bengal, Vol. 30(1-2), pp. 147-148.

Mitsc, W.J. and Gosselink, J.G. (1993). Wetlands. 2nd edition. Van Nostrand, New York. 539 pp.

□

ECOLOGY AND WORLD DISTRIBUTION OF ANIMALS

Bireswar Banerjee
Department of Geography
University of Calcutta, Calcutta

Environment, Ecology and Biomes

The animals have to adapt themselves to their environment for survival. They feel at each in ~~such environment where they get~~ sufficient food, reasonable security from the predators and congenial atmosphere to reproduce. Absence of any one of these parameters means extinction of large number of animal species from their habitat or to motivate them to migrate in large numbers in regions of more congenial environment, suitable for their survival.

Individual species has to face at least three conditions to seek the congenial environment for living. Any disturbance or interruption of these conditions may motive them to spread successfully in new areas. These three conditions are : (i) its physiologicl ability to adjust with the environment; (ii) the colonizing species should find necessary ecological opportunities or niche to survive and multiply; and (iii) its subsequent spread, being controlled by some continuities of suitable habitat.

In the long process of evolution and stabilisation, the species has to face various mechanisms of change, as the aftermath of natural hazards or unscientific human interference with nature. As

a result, the species quite often change their anatomy, physiology and behaviour. The entire process inducts diversities of living bodies. This enables the faunal kingdom to exist over large areas of the diverse environment of the earth.

Since its origin, the earth is passing through cyclic periods of unrest and quiescence. During the periods of unrest continents drifted apart, fluctuations of sea-level took place, widespread vulcanicity created havoc on the landforms, different epochs of Ice Age were followed by Inter-Glacial warm phase, dynamic changes of landforms are the effects of weathering and agents of erosion. Even in modern geological period, the earth is now facing the spectre of global warming, formation of ozone holes in the atmosphere and widespread flooding of the coastal lands. During such periods of unrest, many plant and animal species became extinct and new species evolved through the process of natural selection and adaptation. During the periods of rest in the geological history of the earth, the biotic communities could achieve a harmonious stable stage through various processes of succession. Within such a stable environment, the faunal communities used to live in harmony with each other. Some animals became herbivores while others became carnivores. This established a harmony in the food chain avoiding competitions between themselves for survival. In other words, an ecological balance was established between different environmental elements and other living bodies.

The environment which supports a particular set of plants and animals, not usually found in another ecological region, is termed as Ecological Zone. The ecological classification of earth's environment is also termed as Biomes. Till now, scientists have been able to identify nine ecological zones or biomes in our earth. Each of these biomes is distinguished by its individual climate, plant and animal types. Such climax formation indicates a harmony between environment and ecology, thereby forming different biomes. The different biomes which have been identified till now are (i) Permanent Ice Fields, (ii) Tundras, (iii) Mountains, (iv) Coniferous forests, (v) Temperate forests, (vi) Grasslands, (vii) Tropical forests, (viii) Thorny scrub and Semi-Desert and (ix) Desert with these, the oceans may be said to be a separate biome.

Spatial distribution of animals

Animal species are not uniformly distributed on our earth. Even where thhey could survive, they are not sometimes found. For example, the equatorial forests of central Africa are the habitat of Lions, gorillas, hipopotamus. But these species are not found in the Selvas of Brazil in South America, though the environment is identical to that of the former. On the other hand, the Selvas are the habitat of sloths; tapirs, prehensile-monkeys. Explanation of such contradiction is difficult to offer. According to some, the distribution of animals is entirely limited to congenial environment. As such variations of faunal life are notices in each biome. The variations occur with latitudinal and altitudinal gradients. According to others, aberrations of faunal distribution may be related to the long evolutionary history of each species, requiring more in-depth study. In many cases it has

been observed that organisms within a particular habitat may reproduce much rapidly than the carrying capacities of their respective biomes. This gives pressure on the faunal communities to expand their niche or to disperse in new areas. The biota of the earth are constantly changing. Existing distribution of fauna in many cases bears legacies of the past. This necessitates thorough studies of the fossil remains of faunas during past geological formations, paleoclimate and oceans.

Zoogeographical regions

After careful studies of the spatial distribution of faunas, geo-scientists have identified six major zoogeographical regions, based mainly on the distribution of mammals. The zoogeographical realms are : (i) Palaearctic region, (ii) Nearctic region, (iii) Oriental region, (iv) Ethiopian region, (v) Neotropical region, and (vi) Australian region. Because of many similarities of fauna in the first two regions, they are often grouped as Holarctic region.

(i) Palaearctic Region : This region covers Europe, north of Sahara desert of Africa, Asia north of the Himalaya, North China, Japan and Iceland. Animals native to this region are moles, wild ass, wild sheep, rae deer, hedgehog, dormouce, flycatcher, robin, magpies etc.

(ii) Nearctic region : The region comprises of North America upto Mexico and Greenland. The animals native to this region are Beaver, caribou, opossum, rattle snake, bison, shunk, Prairie dog, Turkey buzzard, mocking bird etc.

(iii) Oriental region : The region covers South Asia, South-East Asia and South China. The animals indigenous to this region are gibbon, tiger, elephant, orangutan, black panther, tree shrew, peacock etc.

(iv) Ethiopian region : This region covers Africa south of Sahara desert, western part of Arabia, Madagascar. Gorilla, chimpanzee, zebra, rhinoceros, hippopotamus, giraffe, African elephant, snakes and secretary bird have their habitat here.

(v) Neotropical region : This region covers whole of South America, Mexico and Carribean countries. Indigenous species of this region are sloths which hang upside down from tree branches, pangolin, howler monkey, rhea and guinea pig.

(vi) Australian region : This region is quite distinct from others. This region covers Australia, New Zealand, Micronesia and Polynesia. This is the home of marsupials, kangroo, kiwi, cat, thylacine (Tasmanian wolf), Opossum and platypus.

Within these six major zoogeographical regions, there are problems of resemblances and differences. For example, North America is connected with South America, but its fauna resemble more to those of North Asia. Similarly though North Africa is not directly connected with S. Europe, the former has faunal similarity with the latter. It may, therefore, be concluded that two disjunctive species might have a common ancestor, but how and through which route they dispersed are difficult to ascertain.

Selected References

Moer, A.N. (1973). Wildlife Ecology. San Francisco.
Leeds, A. & Vayda (ed) (1965). Man, Culture and Animals. Ame. Assoc. Adv. Sci., Pub No. 78.
Moore, H.B. (1966). Marine Ecology. London.
Unesco (1970). Use and Conservation of the Biosphere. Paris.
Kendeigh, S.C. (1980). Ecology Prentice Hall., New Delhi.

□

ON SOME ASPECTS OF THE NEWLY REVISED CLASSIFICATION OF THE PROTOZOA

D.P. Haldar
Department of Zoology, University of Kalyani,
Kalyani 741235, West Bengal

The Protozoa are essentially single celled, eukaryotic organisms. They are not a natural group, but have been grouped together as a matter of convenience. The classical classification of living things divides them into plants and animals and the Protozoa comprise a phylum of animals. Perhaps the most widely used of the more modern classifications is the 5-kingdom classification- MONERA, PROTISTA, PLANTAE, FUNGI and ANIMALIA, where the Protozoa might be considered a subkingdom of the kingdom Protista. If the classical classification is preferred, the Protozoa mignt be considered a subkingdom of the kingdom Animalia. In either case, the former major groups of Protozoa would become phyla.

The first Protozoa were seen by Antony van Leeuwenhoek in 1674. However, in the 1758

edition of his Systema Naturae, Linnaeus included 2 species of free-living Protozoa, but did not include any parasitic ones. At present, over 65,000 protozoan species have been named of which more than 10,000 are parasitic. There are undoubtedly thousands more species yet to be named.

The size of the Protozoa ranges from 1 µm to 50 mm — mostly between 5 and 250 µm. Nearly all are holozoic or saprozoic, but a few are holophytic. Most protozoa have a single vesicular nucleus but some are multinucleate and the Ciliophora are heterokaryotic. Sexual and asexual reproduction are present, depending on the group. The principal line of evolution has been through subcellular specializations or organelles which function in feeding, locomotion, osmoregulation and reproduction.

The classical taxonomic scheme of the Protozoa was developed about the turn of the century. They were considerd a phylum and were divided into 2 subphyla — Plasmodroma and Ciliophora — based primarily on organelles of locomotion. The Society of Protozoologits, in 1964, introduced a new but fairly similar classification of the Protozoa.

Many important and necessary changes have been made in the classification of the Protozoa since 1964 that affected all the major groups. According to the Committee on Systematics and Evolution of the Society of Protozoologists, (Chairman — Prof. N.D. Levine), the 1964 scheme was a step in the development of the present one, but it is now obsolete (Levine *et al.*, 1980). Electron microscopy has provided many new data of taxonomic significance. The Committee things that the revised scheme will be used for many years by both protozoologists and nonprotozoologists, but it is inevitable that it will be modified as new informations are available.

Seven phyla of the Protozoa are accepted in the newly revised classification. These are : **Sarcomastigophora, Labyrinthomorpha, Apicomplexa, Microspora, Ascetospora, Myxozoa** and **Ciliophora**. The classification, according to the Committee (1980), is, to a degree, one of convenience and does not indicate evolutionary relationships. The diagnostic features of the seven phyla are given hereunder :

Phylum I. SARCOMASTIGOPHORA Honigberg and Balamuth, 1963

One or more flagella typically present in trophozoites; asexual reproduction basically by intrakinetal (symmetrogenic) binary fission; sexual reproduction known in some groups.

Phylum II. LABYRINTHOMORPHA Page, 1976

Tropic stage, ectoplasmic network with spindle-shaped or spherical, nonameboid cells; in some genera ameboid cells move within network by gliding; with sagenogenetosome, unique cell-surface organelle, associated with ectoplasmic network; heterokont zoospores produced by most species; saprobic and parasitic on algae, mostly in marine and estuarine waters.

Phylum III. APICOMPLEXA Levine, 1970

Apical complex (visible with electron microscope), generally consisting of polar ring(s), rhoptries, micronemes, conoid and subpellicular microtubules present at some stage; micropore(s) generally present at some stage : cilia absent : sexuality by syngmy : all species parasitic.

Phylum IV. MICROSPORA Sprague, 1977

Unicellular spores, each with imperforate wall, containing one uninucleate or dinucleate sporoplasm and simple or complex extrusion apparatus always with polar tube and polar cap; without mitochondria; often, if not usually, dimorphic in sporulation sequence, obligatory intra cellular parasites in early all major animal groups.

Phylum V. ASCETOSPORA Sprague, 1978

Spore multicellular (or unicellular ?); with one or more sporoplasms; without polar capsules or polar filaments; all parasitic.

Phylum VI. MYXOZOA Grassé, 1970 emend.

Spores of multicellular origin, with one or more polar capsules and sporoplasm; with 1, 2 or 3 (rarely more) valves; all species parasitic.

Phylum VII. CILIOPHORA Doflein, 1901

Simple cilia or compound ciliary organelles typical in atleast one stage of life cycle; with subpellicular infraciliature present even when cilia absent; two types of nuclei, with rare exception; binary fission transverse, basically, homothetogenic and generally parakinetal, but budding and multiple fission also occur; sexuality involving conjugation, autogamy, and cytogamy; nutrition heterotrophic; contractile vacuole typically present; most species free living, but many commensal, some truly parasitic, and large number found a symphorionts on variety of "hosts".

Selected References

Honigberg, B.M. and others (1964). A revised classification of the phylum Protozoa. J. Protozool., **11** : 7-20.

Levine, N.D. (Chairman) and others (1980). A newly revised classification of the Protozoa. J. Protozool., **27** : 37-58.

□

FIGHTING THE BIG C

Twisha Lahiri

Department of Neuroendocrinology, Chittaranjan National Cancer Institute

37, S.P. Mukherjee Road, Calcutta 700 026

For ever so long it was always the story of the triumph of the Big C — **Cancer.** In the last 25 years the scenario has undergone a sea change and the dreaded Big C is fighting a losing battle against the combined multiarmed forces of doctors and scientists armed with newer arsenals of surgery, radiotherapy and chemotherapy which are strengthened by the advancements of molecular biology and biotechnology. Many questions still revolve around the Big C, some answered and some remains to be answered.

Cancer is not a malady of modern civilization, it is known since human societies first learnt to record their activities. It is not a disease of man and higher animals but may affect almost all multicellular organisms and plants worldwide. It is a name that blankets a complex family of diseases with more than 100 different types classified according to cellular variations.

Today about 9 million new cancer cases are detected annually. The figure is almost equal in developed countries and developing countries, although two thirds of the population lives in the developing countries. Eighty percent of all human cancers are caused by environmental factors (chemicals, occupation and life style etc.). Tobacco accounts for 48% of total cancer cases in the world.

Cancer, characterized by unrestrained cell division, invasion and metastasis, is essentially genetic changes in somatic cells. The landmark discovery of oncogenes and tumor suppressor genes (preventing cell proliferation) have brought together the seemingly distinct areas of carcinogenesis on a common platform. Initiating agents (virus, chemicals, radiation etc.) cause DNA alteration to produce oncogenes from proto-oncogenes (its normal counterpart) and or cause mutation of tumor suppressor genes. Proteins encoded of oncogenes and tumor suppressor genes contribute to the malignant transformation. Multiple modification of gene expression may act synergistically to give the malignant phenotype. The integrated regulatory systems of the body which include the endocrine, nervous and immune systems influence the growth and of course of cancer progression in the host.

Abnormal growth control in cancer takes place by alteration in one or more steps in the signaling process, probably influenced by oncogenes. The production, release and transport of the signaling substances (neurotransmitters, hormones, growth factors etc.) may be altered. Similarly receptor expressions may be altered with respect to its number, structure and function, thus generating anomalous signal. The intracellular messenger system may also be altered. How,

when and why these changes take place and whether therapeutic management is possible is the current focus of Cancer Research.

Cancer is conservatively treated by surgery, radiation and chemotherapy. Modern methods also include hormone therapy as well as immunotherapy. The selection of the therapy depends on the type of cancer and the stage of progression.

The best treatment comes from multidisciplinary approach fitted with the right permutation and combinations. Approximately 80% of the early cancers (solid tumors, such as breast, cervix, mouth, tongue, stomach, colon, rectum) can be treated with surgery and radiotherapy. The newer physical methods of imaging employing computerized tomography (CT) and magnetic resonance imaging (MRI) are of great importance not only for diagnosis but also for conformational radiotherapy planning. Immunological methods of imaging are being developed to detect distant metastasis.

There have been considerable advances in chemotherapeutic treatment specially in leukemias and tumors of the young adults. Although certain cancer of older patients, such as carcinoma of breast stomach, colon are often refractory to curative chemotherapy, newer drugs are being developed to combat the problems of drug resistance, acute side effects and myelotoxicity which often accompanies cancer therapy.

Current immunological vehicles of targeting cytotoxic agents to the tumor are being developed. Interferon treatment, though had great start, presently is only curative for hairy cell leukemias. Other cytokines like IL-2 are being evaluated for stimulation of hosts' immune responses. In the recent years progress has also been made in palliative treatment, designed to improve the quality of life remaining to the affected individual.

Since 80% of all cancers are related to environmental factors (chemicals, radiations, habits and life style), presently much emphasis is being given to the area of preventive oncology. Research in this area is directed towards identifying carcinogens in the environment and work place, studying the genotoxic and other oncogenic exposure effects on the population and taking appropriate measures towards reduction of exposure to these agents. In India the annual tobacco attributable mortality has been estimated to be 6,30,000 adult death. Therefore stern measures have to be taken to stop tobacco use. Preventive oncology also includes intensive cancer screening programmes which enable early detection of cancer and reduce mortality to a great extent. Life style, habits and diets are important in prevention of cancer. It is now established that vegeterians have a lower risk of developing cancer. Vegerables like cabbage, cauliflower, broccoli etc. and fruits containing vitamins A, C, E, folic acid; fibre and β-carotene and minerals such as calcium and selenium have chemopreventive activity. Turmeric containing curcumin, garlic, soyabean have been shown to have cancer preventive properties, so is fish oil with omega 3 fatty acids.

The war is on - on all fronts, with multidisciplinary arsenals. We all hope the Big C will surrender in not too distant future.

Selected References

Introduction to the cellular and Molecular Biology of Cancer. 2nd Edition 1993. Editors L.M. Franks & N.M. Teich. Oxford Medical Publication. Oxford, New York, Toronto.

Current opinion in Oncology. Breast. Vol. 9, no. 6, 1997. Ed. Martin D. Abeloff.

Cancer Epidemeology Biomarkers & Prevention. Vol. 5. no. 10, 1998.

Monfardini, S. Ed.. Manual of Cancer chemotherapy. 3rd Edition. UICC Tech. Rep. Series Vol. 56. UICC. Geneva.

Higginson, J., Muir, C.S. and Mumoz, N. (1993). Human Cancer. Epidemiology & Environmental Causes. Cambridge University Publication.

□

FUNCTIONAL IMPLICATIONS OF THE PINEAL HORMONE MELATONIN : "A JACK OF ALL TRADES"

Saumen Kumar Maitra

Department of Zoology, University of Burdwan,

Golapbag, Burdwan - 713 104

The compound 5-methoxy-N-acetyl-tryptamine, first isolated and purified from the cattle pineals by Aaron Lerner and his co-workers in 1958, was named as **Melatonin** because of its blanching effects on melanin pigments within the melanophores in amphibian larvae. But within the past four decades, knowledge about the pineal gland and its chief hormonal product, melatonin, have attracted researchers from virtually every discipline of biological and medical science. The results have been a veritable explosion of new information concerning multiple actions of pineal and/or melatonin on a wide variety of body functions.

Source

Though pineal is the primary source of melatonin in all vertebrates, evidences are available to show that the retinae, Harderian glands, and gut are the additional sites of synthesis and release of this indole hormone.

Potency

The potency of melatonin is more than 10,000 times greater than the potency of any other compound.

Concentration

The concentration of melatonin in rat pineal gland is about 0.4-4.0 µg/g during the day and 2.0-7.0 µg/g at night.

Biosynthesis (Yu and Reiter, 1993)

The general mechanism of biosynthesis of melatonin in all the animals has been shown to be identical. The process is initiated by the uptake of L-troptophan from the blood stream. The pineal gland takes up tryptophan from the blood against a concentration gradient that utilized the amino acid in the synthesis of melatonin and other indoles. Within the pinealocytes, 5-hydrocytryptamine or serotonin is produced by the action of two enzymes. The first *tryptophan hydroxylase* converts tryptophan to 5-hydroxy-trytophan. The second, *aromatic amino acid decarboxylase* proceeds decarboxylation of 5-hydroxytryptophan to form serotonin. The concentration of serotonin in the pineal gland is very high. Within the pineal gland, serotonin may undergo different metabolic pathways : (a) oxidative deamination by *monoamine oxidase* (MAO) to produce 5-hydroxytryptophol; and (b) N-acetylation by *N-acetyltrans-ferase* (NAT) to produce N-acetyl serotonin, which in turn is methylated by *hydroxyindole O-methyl transferase* (HIOMT) to produce N-acetyl-5-methoxy tryptamine or **melatonin**. The activity of NAT, which appears to be the rate-limiting enzyme for the biosynthesis of melatonin, undergoes precise circadian variation with a peak at mid-night and is very sensitive to light. It has been found that light immediately inhiblts NAT enzyme activity in rat, chick, and quail. The HIOMT activity of the pineal gland varies in relation to constant light continuous darkness (Arendt, 1995).

Metabolism

Melatonin being a highly lipid soluble hormone is simply diffused out of the cell *en route* to its targets. Unlike most transmitter and hormone systems, there are no specific storage or release mechanisms for melatonin.. Blood is the primary site of secretion of melatonin. It has been found that about 60-70% of te total melatonin in the blood is transported in albumin-bound state and remaining part is carried in the free state. Melatonin is rapidly taken up by the tissues and is metabolized in several indoles and non-indole derivatives and is excreted through the urine from the body. In addition, a considerable amount of melatonin is excreted through the urine in its original form (Reiter, 1991).

Regulation

One of the striking features of melatonin biosynthesis is that the activity of rate-limiting enzyme NAT is strictly dependent on environmental ligting, the absence of which initiates the process (Vollrath, 1981). Because of this unique feature, melatonin is often described as the 'hormone of darkness'. During day-time, photic information arrives to the pineal gland through a complex, multisynaptic neural pathway that starts in the eye, synapses in the CNS and leaves CNS to the superior cervical ganglia, SCG. From the SCG postganglionic sympathetic fibres finally approach the pineal together with pineal blood vessels or via two bilaterally symmetrical nervous conarii. This sympathetic innervation provides the major regulatory input to the gland. The dominant inhibitory effect of light on pineal melatonin synthesis results from the light induced suppression of norepinephrine (NE) release. Conversely, during darkness, when the inhibitory influence of light is absent, NE release is enhanced. NE binds with the β_1 adrenergic receptor to stimulate cAMP production which in turn, triggers the induction as well as stimulation of NAT activity. Simultaneous stimulation by NE of pinealocyte a_1 adrenoreceptors potentiate the b_1-adrenoreceptor response through actions of the phosphoinositide system, especially protein kinase C. Sympathetic fibres innervating the pineal have been shown to contain neuropeptide Y (NPY) as well as NE and this peptide also appears to affect melatonin production (Pang and Reiter, 1996).

Functional Implications

A large body of information is currently available to show that melatonin participates in several neural and neuroendocrine mechanisms. Carefully controlled studies have implicated melatonin in so many diversified functions (Ebadi *et al.*, 1989). Including mechanism involved in the regulation of aggression, aging, antimiotic activity and influencing malignancy, cell proliferation, ethanol preference, free radical scavenger, geomagnetic response, hibernation, hypertension, hyperexcitability state and epilepsies, maintenance of circadian periodicity and organization, maintenance of circadian periodicity and organization, maintenance of normal blood pressure, maintenance of sleep-wake cycle, menopause, general metabolism, modulating immune mechanisms, modulation of hypotalamic-pituitary axis, modulator of pituitary adrenal axis, puberty, fertility and pregnancy, response and general adaption to stress, schizophrenia, seasonal affective dysorders (SAD), synchronization of hibernatory events, thermoregulation, shift of sleep-wake cycle ("the Jet lag"), thirst and electrolyte balance. However, the physiological function which appreared to be highly sensitive to the changes in the endogenous milieu of melatonin, is the reproduction in seasonally breeding animals.

(a) Melatonin in the Regulation of Reproduction in Higher Vertebrates

A mass of data collected during the recent past indicated that the daily pattern of secretion of melatonin from te pineal and extra-pineal sources transduces the environmental light-dark cycle

into a signal influencing the endocrine control of sexual maturation in seasonally breeding vertebrates. An early study implicating pineal in the physiology of the gonad of rat by Wurtman *er al.*, in 1963 demonstrated that melatonin injection could suppress the ovarian growth and functional activity. Since then numerous investigations under various conditions have revealed that melatonin administration on rats delays vaginal opening, inhibits ovulation and ovulation dependent LH surge. In male rats and hamsters, melatonin injection is known to decrease testis weight, sprematogenesis, and plasma testosterone level; and to inhibit testicular steroidogenesis in vitro, and androgenic effects. These changes are accompanied by decrease in FSH and LH secretion from the pituitary with increased release of prolactin upon the way of administration (Ng and Chan, 1993).

In last few decades, considerable amount of data have been accumulated to show that exogenous melatonin is antigonadal, and this action depends upon the dose and time of administration of melatonin, as well as the age of the animal, season of the treatment and the photoperiod under which the animals were exposed (Reiter, 1996). Melatonin depending upon the dose may act in an antigonadal or progonadal agent; while lower amount of infusion from the implants causes testicular regression, higher rate of melatonin infusion resulted in stimulation of testicular activity. However, one striking feature of melatonin administration is that the same dose may effectively decrease tisticular proliferation at a particular time within the 24 h LD cycle while at other time it may not exert any impact. Several studies have shown that the late light period is the most sensitive point during which administration of melatonin results in gonadal regression. In contrast, constant release implants of melatonin can prevent thhe testicular activity in hamsters and rats exposed to short photoperiod or to evening melatonin injection. This effect, called the counter-antigonadotrophic effect, of melatonin can be explained in terms of modification of sensitivity thershold at the level of melatonin receptor. Continuous exposure to melatonin, may render the target tissues relatively insensitive to the effect of exogenous or endogenous pulses of melatonin by "down regulation" of the melatonin receptors and thus reverse effect of melatonin is exhibited.

The nocturnal rise of endogenous melatonin is directly related to te attendant period of darkness. Since short days have been shown to produce potent inhibitory effects on reproduction, it was assumed that melatonin would also cause suppression of sexual physiology. The results of the studies on a number of mammals like hamsters, rats, ferrets, rams, goats, and meadow voles, in general suport the view that the pineal or especially melatonin is the candidate to modulte the photoperiod-induced changes in the reproductive functions. It was demonstrated that melatonin when injected during the late light phase to hamsters maintained under long photoperiod resulted in a total reproductive collapse. The study on mice and meadow voles also gave similar results.

An extensive study of the role of continuously available melatonin on photoperiod-induced testicular activity indicated that constantly available melatonin (i) inhibits testicular activity when the photoperiod is stimulatory; (ii) stimulates testicular function when the photoperiod is inhibitory; and (iii) has no effect on the testicular proliferation when the photoperiod has no effect on the

gonadal activity.

The presently available meager data suggest that the pineal gland does have certain role to play in the control of reproduction in birds, but collectively fail to reach a firm conclusion. A small information base, a few number of investigated species and limited experimental manipulation makes the picture more enigmatic. Though several studies in birds demonstrated an inverse functional relationship between the pineal and gonads, the gonadal response to pinealectomy is still confusing. Moreover, controversy still resounds over the efficacy of melatonin on reproductiveactivity in relation to the dose of hormone, duration of treatment, time of administration, the photoperiodic condition to which the animals are exposed, age and reproductive status of the birds. Despite the fact that the avian pineal shares several features in common, the activity of mammalian pineal including thhe biosyntesis of melatonin, its rhythmic pattern of secretion as well as the effect of light and darkness on, the endogenous milieu of melatonin, the mechanism of melatonin-mediated synchronization of reproductive activity with the photoperiod, and especially, the sites and mechanism of action of melatonin in birds remain largely unknown. It is true that some progress is being made to characterize receptors and identify anatomically the sites of action of melatonin (Ayre and Pang, 1994), but the greatest challenge is to understand the mechanism by which melatonin conveys endocrine modulatory information to diverse loci within the neuroendocrine-reproductive axis in birds. In addition, studies of the physiological balance among the different inputs arriving at the pineal cells to synthesize and/or secrete melatonin as well as understanding of action of melatonin at the molecular level in relation to the modulation of gonadal activity are some of te intriguing areas of future research (Maitra and Dey, 1997).

(b) Melatonin in thermoregulation

In ectotherms, the melatonin rhythm is abolished by low constant temperatures and enhanced by high constant temperatures or thermocycles of high daytime and low nighttime temperatures. Pinealectomy in birds and mammals also affects regulatory mechanism of body temperature (Kachi, 1987).

(c) Melatonin in the regulation of sleep

In man and chickens, melatonin induced sleepiness or sleep, while in cats and rats, the slow-wave sleep (SWS) - inducing effect was various depending on the site, the dose, and the time of day at which melatonin was administered. It has been hypothesized that the nighttime rise of melatoning may function to enhance the behaviour normally associated with night in both diurnal and nocturnal species (Maestroni *et al.*, 1997).

Clinical considerations : In case of the patients, where the sleep pattern is not abnormal, but the timing of sleep onset is abnormal with regard to local time, evening administration of melatonin (5 mg) should phase advance the sleep-wake cycle so that sleep onset occurs at an

appropriate time in the evening/night (Brown, 1994).

Melatonin as an anti-"jet-lag" agent (Maestroni *et al.*, 1997) : In humans, a transient external desynchronization accompanied by internal dissociation follows sudden changes in body functions produced by rapid intercontinental jet flight. The phenomenon of 'jet-lag' is thought to reflect internal dissociation; different bodily rhythms take different lengths of time to re-entrain, or may entrain in different directions. As a result of trails involving over 20 subjects, there is no doubt that ingestion of 5 mg of melatonin at bedtime of the new destination minimizes remarkably subjective feelings of jet lag.

(d) Psychology and Behaviour (after Katchi, 1987)

Aggression : At least in isolation-induced aggression and territorial aggression the pineal gland plays a stimulatory role in aggressive behaviour.

Exploratory activity : The pineal gland may play an inhibitory role in exploratory behaviour especially in hypoactive animals.

Emotional-arousal response : The pineal actions on the emotional-arousal system are inhibitory.

(e) Affective Disorders (e.g., Depression)

Low levels of plasma melatoning have been reported in special types of depression. Antidepressant drugs like desipramine increased the nocturnal level of plasma melatonin in depressed patients (Brown, 1996). Seasonal Affective Disorder (SAD) is a syndrome characterized by recurrent depressions occurring annually at the same time each year. In 35 cases of Winter SAD patients, involvement of pineal is under consideration since, (a) the weight of the pineal gland of man decreases in northern areas of Japan, (b) blood melatonin shows lower levels in young healthy man studied in both France and Finland, (c) decreased nocturnal rise of blood melatonin level in winter has been found in tammar.

(f) Cancer (Reiter, 1996)

The use of pineal extracts to treat patients with tumors began to appear about 46 years ago. Sixteen patients were treated with inoperable carcinoma with pineal preparations; in many of the subjects the pain associated with the tumors was reportedly relieved and in some cases a regression of the tumorous masses was noted. It was reported further that patients with tumors have lower levels of melatonin, in fact in few patients it was not detectable at all. An estimation of the 24 h urinary melatonin profiles in postmenopausal Indian women, who were either free of tumors or possessed advanced breast carcinoma, revealed that those with the tumors excreted about 30 times more melatonin in their urine (Gupta *et al.*, 1988). Absence of 24 h rhythm in blood melatonin was also found to be lost in men with prostatic carcinoma, while this was present in patients with

benign prostatic hyperplasia. One of the most significant findings on the relationship of melatonin to mammary carcinoma that in 19 & 20 women patients with clinical stage I and II breast cancer, there was a high degree of correlation between peak melatonin levels in the blood and estrogen receptors in the breast tumors. Though the molecular mechanism of the involvement of pineal or its secretory products in the suppression of cell division remains unknown, some are of opinion that melatonin has a colchicine-like action in terms of mitotic spindle formation. It would seem likely that melatonin would be most useful in the case of tumors of endocrine origin since the indole has often been found to be inhibitory to endocrine physiology (Reiter, 1996).

(g) Geo-Magnetic Response (John *et al.*, 1996)

Semm and colleagues (1980) were the first to show that the pineal, unlike other brain areas (e.g., epithalamus, Corpora quadrigemini and Corpus Callosum), in the guinea pigs responds to a short term inversion of the horizontal component of the earth's magnetic field (MF). Subsequent studies on the pineal of the pigeon, quail and human, rat and mice also supported the study on guinea pigs. It is interesting to note that magnetic stimuli stronger than the earth strength were ineffective on rat pineal melatonin synthesis. Artificial earth-strength MFs, on the other hand, were found to depress the pineal content of melatonin, as well as HIOMT and NAT during, dark but not light, phase. The pineal gland is not directly sensitive to artificial MF. The MF response of pineal requires an intact visual system and also presence of dim light during night. The animals in total darkness fail to undergo pineal inhibition following an alteration in MF. MF perception in rodents appears to be independent of sex, but dependent on skin pigmentation. The molecular mechanism of pineal response to MF, however, is not yet settled. Since MF in earth undergoes circadian, lunar and circannual changes, there is reason to believe that organisms capable of perceiving temporal variations of MF could determine not only their geographical location, but they could also obtain information for synchronizing biological rhythms (John *et al.*, 1996).

(h) Antioxidant Actions and Aging (Reiter, 1997)

There are many explanations for aging, but the theory which has been refined many times and evidence supporting it has accumulated steadily is the free radical theory of aging. As envisaged in this theory, the single causative factor is the excessive generation of free radicals and their associated reactions. A corollary of the theory is that the life span of any organism will be prolonged if the initiation of random free radical reactions is slowed or otherwise limited. The former would be acieved by reducing factors that lead to the production of free radicals, e.g., reduced ingestion of easily oxidizable dietary constituents, lowered stress, etc., while limiting free radical reactions can be achieved by increasing concentrations of agents that either neutralize or metabolize free radicals. Under ideal conditions, oxidant production is counterbalanced by an antioxidative defense system so cellular damage is held to a minimum. However, some tissue damage is unavoidable and it

accumulated gradually during aging. Since the first demonstration of a role of melatonin in the antioxidative defense system of the organism in 1991, the data accumulated within a very span in the current decade clearly indicates that melatonin may be involved in age-related free radical diseases and aging and in this regard melatonin has been proved to be roughtly a 5 times better scavenger than commonly occurring glutathion and nearly 15 times better than mannitol. Melatonin, when exogenously administered, rapidly gets into the brain where it acts as both a direct and an indirect scavenger. One consistent feature of endogenous melatonin production in the pineal gland is that it drops steadily throughout life such that, in most old animals (including human), blood and tissue levels are low. Considering the potential role of free radicals in the process of aging, the loss of melatonin could be a factor contributing to thhe declining functional integrity of cellular organelles, cells, organs, and organ systems as organisms are (Reiter, 1997). Whether supplement melatonin would avert age-related degenerative process is under investigation.

(i) The Internal Time-Keeper of the Body ?

. The pineal hormone melatonin has been shown to have some influence on nearly every physiological system or disease of that system. Internal desynchromy represents disorder, and if this sustained the results may be injurious to the organism and suceptibility to disease may follow. The pineal may play a role in synchronizing, acting as a coupling device or coordinating daily internal rhythmic changes. ".....if the pineal gland plays a fundamental role in presenting internal desynchrony, plasma melatonin must be a prime candidate as the internal time-keeper". - Armstrong (1989).

Conclusion

The research for and discovery of how the pineal hormone melatonin with its apparent omnipotent effects, brings forth these multiple functions may raise the exciting prospect of prividing new avenues of treating numerous diseases, thus replacing old treatments whichsustain life but diminish its quality. The total functions of melatonin would be to orchestrate, to synthronize, and to refine the multiplicity of biological fucntions which make life possible.

Selected References

Arendt, J. (1995). "Melatonin and the Mammalian Pineal Gland". Chapman & Hall. Weinheim, New York, London.

Armstrong, S.M. (1989). Melatonin : The internal Zeitgeber of mammals ? *Pineal Res. Rev.*, **7** : 157-202.

Ayre, E.A. and Pang, S.F. (1994). 2[^{125}I]-iodomelatonin binding sites in the testis and ovary : putative melatonin receptors in the gonads. *Biol. Signals* **3** : 71-84.

Brown, G.M. (1994). Light, melatonin and the sleep-wake cycle. *J. Psychiatr. Neurosci.*, **19**, 345-

353.

Brown, G.M. (1996). Pineal function in psychiatric disorders. In : "Melatonin : A Universal Photoperiodic Signal with diverse Actions" (Eds. Tang, P.L., Pang, S.F. and Reiter, R.J.). Krager. Basel, Freiburg, Paris, London.

Ebadi, M., Hexum, T.D., Pfeiffer, R.F. and Govotrapong, P. (1989). Pineal and retinal peptides and their receptors. *In* : "Pineal Research Reviews" (R.J. Reiter, Ed.), Vol. 7, pp. 1-156, Alan R. Liss, New York.

Gupta, D., Attanasio, A. and Reiter, R.J. (1988). *The Pineal gland and cancer.* Brain Research Promotion, London, Tubingen.

John, T.M., Liu, G.-Y. and Brown, G.M. (1996). Electromagnetic field exposure and indoleamine metabolism : An overview. In : "Melatonin : A Universal Photoperiodic Signal with Diverse Actions" (Eds. Tang, P.L., Pang, S.F. and Reiter, R.J.). Krager. Basal, Freiburg, Paris, London.

Katchi, T. (1987). Pineal actions on the autonomic system. *Pineal Res. Rev.*, **5** : 217-263.

Lerner, A.B., Case, J.D., Takahashi, Y., Lee, Y. and Mori, W. (1958). Isolation of melatonin, the pineal gland factor that lightens melanocytes. *J. Amer. Chem. Soc.*, **80** : 2587.

Maestroni, G.J.M., Conti, A., and Reiter, R.J. 91997). "Therapeutic Potential of Melatonin". Krager, basel, Freiburg, Paris, London.

Maitra, S.K. and Dey, M. (1997). Regulation of annual testicular events in roseringed parakeets : Role of photoperiod, pineal and melatonin. *In* : 'Frontiers in Environmental and Metabolic Endocrinology' (Ed. S.K. Maitra). The University of Burdwan Publications, Burdwan, India. pp. 171-191.

Ng, T.B. and Chan, W.Y. (1993). Action of pineal indoleamines on the reproductive systems of the male C57 mouse and golden hamster. *J. Neural Transm.*, **93** : 87-98.

Pang, P.L. and Reiter, R.J. (1996). "Melatonin : A Universal Photoperiodic Signal with Diverse Actions". Krager. Basel, Freiburg, Paris, London.

Reiter, R.J. (1991). Pineal melatonin : Cell biology of its synthesis and of its physiological interactions. *Endocrine Rev.*, **12** : 151-180.

Reiter, R.J. (1996). The pineal gland and melatonin in relation to aging. A summary of the theories and of the data. *Exp. gerontol.*, **30** : 199-212.

Reiter, R.J. (1997). Antioxidant actions of melatonin. *Adv. Pharmacol.*, **38** : 103-117.

Semm, P., Schneider, T. and Vollrath, L. (1980). Effects of an earth-strength magnetic field on electrical activity of pineal cells. *Nature* **288** : 607-608.

Vollrath, L. (1981). *The Pineal Organ.* Springer Verlag, Heidelberg, New York.

Wurtman, R.J., Axelrod, J. and Chu, E.W. (1963). Melatonin, a pineal substance : Effect on the rat ovary. *Science* **141** : 277-278.

Yu, H.S. and Reiter, R.J. (1993). ***Melatonin biosynthesis, physiological effects and clinical applications.*** CRC Press, Boca Raton, Florida.

A NOTE ON AGENDA 21

A.K. Ghosh
Centre for Environment and Development
Jodhpur Park, Calcutta 700 068

Salient Features

I Social and Economic Dimensions

Sustainable Development
Combating Poverty
Changing Consumption Pattern
Demographic Dynamics
Human Health
Human Settlement
Integrating Environment & Development in decision making

II Conservation & Management of Resources for Development

Atmosphere
Land Resources
Deforestation
Desertification & Drought
Fragile Ecosystem : Mountain
Sustainable Agriculture
Conservation of Biological Diversity
Biotechnology : Sound Management
Ocean & Seas
Freshwater Resources
Management of toxic Chemicals
Management of Hazardous Waste
Management of Solid Waste Sewage
Management of Radioactive Waste

III Strengthening the Role of Major Groups

Women
Children & Youth
Indigenous People

NGO's
Local Authorities
Workers & Trade Unions
Business & Industry
Technological Communities
Farmers

IV Means of Implementation

Financial Resources
Environment Sound Technologies
Science of Sustainable Development
Education and Public Awareness
Capacity Building
Int. Institutional Arrangement
Int. Legal Instruments
Information for Decisions Making

A Total of 40 items —

Selected References

U.N (1992). "Agenda 21. *In* Earth Summit '92". New York

□

BIODIVERSITY CONSERVATION

A.K. Ghosh
Centre for Environment and Development
Jodhpur Park, Calcutta 700 068

Introduction

The Convention on Biological Diversity was one of two major agenda items for intense discussion and negotiation during UN conference on Environment and Development in June 1992. The convention was signed by more than 140 countries. The objectives of the convention includes conservation of biodiversity, its sustainable use and fair equitable sharing of benefits resulting there of. The CBD recognised for the first time soveregin right of the nation over the biodiversity within its domain. Out of 42 articles of convention, some major issues were emphasised.

Such issues include General measures for conservation and sustainable use (Article 6), calling for development of national strategies and integrating conservation and sustainable use of biological diversity into relevant sectoral or cross sectoral plans. Identification and monitoring of components of biological diversity as also the factors which might have adverse effects become the main theme for Article 7. Since conservation becomes thhe most focussed issue, both in-situ (Artical 8) and ex-situ (Article 9) conservation measures are called for.

Issues

While conservation has been the main theme, the necessity for continued use of biological diversity — both domesticated and wild have never been overlocked; but thhe emphasis on sustainable use pattern was rightly laid under Article 10.

No conservation could possibly be supported by community without sociallysound measures that act as incentives. The CBD document has urged for such insentives under Article 11.

The issue of biological diversity needs to be integrated with a process currently being excerised worldwide i.e. Environmental Impact Assessment. In India, under EIA notification of 1994, 29 sectors of development now require EIA exercises. CBD under Article 14 states that each contracting party should "introduce appropriate procedures requiring EIA or its proposed projects that are likely to have significant adverse effects on biological diversity:.

One of the major questions raised during negotiations was the modalities to be adopted for accessing genetic resources. CBD again suggested a directive principles thhat "Access where granted shall be on mutally agreed terms" and "Access to genetic resources shall be subjected to prior informed consent" (Article 15). Corelated issues regarding transfer of

technology among contrusting parties and stressed that such transfer to developing countries shall be facilitated under fair and most favourable terms. Obviously, thhe sensitiveness of the issue and transfer calls for new legislation and policy instrument in each of the contracting party-country (Article 16).

. The Convention further calls for exchange of information (Article 17), technical and scientific cooperation (Article 18), and distribution of benefits (Article 19).

The implementation of CBD is connected with financial resources and mechanism. Criteria and guidelines for eligibility for access to and utilisation of the financial resources was to be determined by the Conference of Contracting Parties (Articles 20,21). A Secretariat has since been established to facilite such a function and COP mettings are regularly being held, next one being due in April 1998.

The provisions of the articles become obligatory to all parties; during 1992-97 period, each country has initiated action to prepare Status Report on Biodiversity, Action Plans to fulfill the obligation and exercises on formulating Biodiversity Conservation Act.

India and CBD

However CBD remains silent on the issues of ownership of biological resources as also modalities of equity sharing. In India intensive exercises are going on in these issues as also on assessment and monitoring.

In order to understand India's position, one can look at the ecosystem level, species level and genetic level of biodiversity, institutional support available and needed, expertise level, current regulations etc. Tasks ahead have also been identified. The annexure provides the salient points to appreciate the above mentioned issues.

Biodiversity

Genesis of Concept

— UNCED 1992 Rio De Janerio

Convention on Biological Diversity
Frame work Convention on Climate Change
Agenda 21

— India as a signatory of CBD

Obligations
. Assesment
Action Plan
. Legislation

— *India 2.4% Global space but what an Ecosystem Diversity !!*

High Mountains
Forest
Fresh water
Marine & Coastal
Desert
Islands

Species Diversity

In the Wild
Domesticated
Land races & breeds

Genetic Diversity

Animals (Other than Fish)
Fishes
Agricultural Crops

Assessment

81,000 species of fauna
47,000 species of flora
Nearly 10% of Global
biodiversity in 2.4% of Global space
Country of Magadiversity
one amongst 12 holding
80% of biodiversity
Two of the 18 HOT SPOTS

Western Ghats
North East India
Endemics
Exotics

Ethnic knowledge of biodiversity
Sacred groves & temple ponds
Rare and endangered species
Living fossils

Action Plan

Current status : gaps
Institutional efforts : ZSI, BSI, WII etc
Crisis in capacity
Networking - intra country
neighbouring countries
Legislations & policy statements
PA systems : Critical analysis

Legislations

India Wildlife (Protection) Act
CITES
Forest Conservation Act
Coastal Zone Regulation Act & Rules
Convention on Migratory species
UNCLOS

TASKS ahed

Complete assessment of 30%
(remaining area)
Monitoring population & Ecosystem
Marine PA System : Strengthening
Wetlands Policy & Law
Law on Access & Transfer
Determine method for equity sharing
Prospecting biodiversity : R & D
investment - areas
Capacity building up in Taxonomy
Soil Microbial organisms
CBD-IPR-
-CBD-Climate change

Development Alternatives

Land & water based system :
management strategy
People's participation

Selected References

U.N. (1992). "Convention on Biological Diversity", New York.

□

APPLICATION OF ECOLOGICAL PRINCIPLES IN AQUA FARMING

A. Kaviraj

Department of Zoology, University of Kalyani

Success of aquaculture in a freshwater boty depends on proper management of the environment and the organisms maintained in that environment. Principal freshwater aquaculture organism in India is fish. Management of environment for fish, manipulation of their stocking density, feed utilization and harvesting of fish in modern aquaculture utilizes some basic principles of ecology. Proper application of these ecological principles in an aquaculture pond help the aquaculturist not only to maintain a stable condition of the pond ecosystem but also to obtain maximum production for the pond.

Management of Environment

The most important ecological criteria on which fish production depends heavily is the primary production of pond. Primary production is defined as the fixation fo light energy by green plants in the form of organic matter (Kormondy, 1986). It refers to photosynthetic activity of the pond. Net primary production (NPP) is referred to the amount of production left after part of gross primary production (GPP) is burnt in respiration. Ratio of net primary production to community respiration (NPP:CR) is an important criteria to determine the stability of an ecosystem. High NPP value often results imbalances in the pond ecosystem. Some physico-chemical parameters are intimately associated with primary productivity of water. These include carbon dioxide, dissolved oxygen, pH, alkalinity etc. To maintain optimum values of these parameters some knowledge on the ecology and chemistry of these parameters are necessary.

a) Carbondioxide, pH and alkalinity :

In a clear body of water carbon dioxide is available primarily from atmosphere or respiration of aquatic organisms. As soon as carbon dioxide comes in contact with water it undergoes following reaction : $CO_2 + H_2O \quad H_2CO_3^- \quad H^+ + HCO_3^- \quad H^+ + CO_3^{=}$ .....(3). $H_2CO_3^-$, HCO_3^- and $CO_3^{=}$ are called combined carbon dioxide. Carbon oxide remaining free of these reactions is called free CO_2 . In a body of water receiving carbon dioxide there is a mixture of free carbon dioxide (both dissociated and undissociated), bicarbonate and carbonate in dissociated form. Under normal condition this mixture maintain a buffer condition which helps to adjust a fluctuation of pH. If hydrogen ion is added to the system (tending to lowers its pH) it will be captured by carbonate to form bicarbonate moving equation no.3 towards left. On the contrary if hydroxyl ion is added to the system (tending to increase its pH) it combines with hydrogen ion forming water and thereby removes hydrogen ion from the system. Under this situation bicarbonate or carbonic acid will dissociate to replace the lost hydrogen ion moving equation no.2 or 3 to the right. During photosynthesis green plants take free carbon dioxide from water. It forces the equation no. 1 to shift to the left. This results in removal of H^+ ion from the system. If sufficient bicarbonate is available in solution it dissociates to compensate the loss of H^+ ion. Otherwise pH of the system will increase. Thus in ponds with high level of primary productivity pH may significantly increase during day time as a result of photosynthesis. Conversely at night when photosynthesis ceases respiration by plants and animals adds carbondioxide to the system and subsequently pH decreases. In a poorly buffered system the diel change in pH can actually range from 6.00 to 10.00. Such changes in pH can be detrimental or lethal to aquatic animals. This diel change can be avoided if the system is well buffered. This can be accomplished by maintaining sufficiently high alkalinity (Goldman and Horne, 1980).

b) Dissolved oxygen :

Dissolved oxygen is the most critical water quality variable. It is contributed into water by diffusion from atmosphere and from photosynthesis. Dissolved oxygen (DO) is consumed in respiration by plants and animals, COD and BOD of water. In general for respiration of aquatic animals a minimum value of 5 mg/L DO is required in water. But for current commercial aquaculture a higher value of DO is required. If sufficient DO is not maintained in aquaculture pond fish will be stressed leading to loss of appetite and increase in the susceptibility to diseases. Even slight reduction in DO leads to reduced growth rate and suboptimal food conversion efficiency (FCE). Do has an inverse relationship with water temperature. At 10°C the solubility of O_2 in water is 11.3 mg/L while at 20 0176 and 30°C the value decreases to 9.1 and 7.6 mg/L respectively. In aquaculture pond depletion of DO may be resulted from several reasons such as high biomass and feeding rate, decline in phytoplankton, continuous cloudy day,

increase in BOD etc. Surfacing of fish or movements of shrimps in shallow water are the symptoms of DO depletion in water. Generally lowest DO is observed at dawn. Aeration is thus must in modern aquaculture. During depletion of DO feeding must be stopped because fish do not take food under oxygen stress and unconsumed food results in decomposition thereby exaccerbating depletion of DO. $KMnO_4$ treatment to increase DO of water is not desirable because it may be injurious to fish and plankton. Pure oxygen in compressed gas form or liquid oxygen (LOX) are becoming popular for use in pond.

Management of Fish Stock

Manipulation of stocking density, growth potential, feed utilization and harvesting requires some basic knowledge of ecology. Growth of fish is considered as elaboration of fish tissue during any time interval. Each species has an innate capacity to grow whichis called its biotic potential. Maximum size or absolute biotic potential is never possible because of environmental resistance (Kormondy, 1986). Therefore, a sigmoid pattern of increase in size with age is generally exhibited by fish. At the beginning, the growth is slow, then it is accelerated and become exponential which can not continue for long because environmental resistance slows doen the growth and finally it culminates in equilibrium between absolute biotic potential and environmental resistance. When growth is exponential it is expressed mathematically as dB/dt = GB, where dB and dt are changes of biomass (B) and time (t) respectively and G is the natural rate of growth or specific growth rate. Whe environmental resistance comes to act on it the curve as well the equation changes. The same equation is multiplied by (K-B/K) (environmental resistance) to evaluate the sigmoid growth (Kormondy, 1986). K refers to maximum weight. In aquaculture only exponential growth period of IMC is exploited. However, stocking is done at fingerling stage when growth rate is slow. If stocking is done at size when growth rate is in accelerating stage quick return is possible. But exponential growth depends on the availability of adequate energy. Althoug energy basically comes from carbohydrate, fat and protein, energy for growth is obtained mainly from protein (Stickney, 1994). Digestible energy requirement for IMC is 2800-3100 Kcal/Kg feed. Diet is prepared in such a way so that energy required for basal metabolism is met from carbohydrate and fat sparing protein for growth only. Thus not only total digestible energy but also quantity of protein is an important criteria. Protein to energy ratio (P:E) is thus an important criteria for feed formulation. P:E for IMC is 95 mg protein/Kcal DE and protein requirement is 300g/Kg. Efficiency of a diet can be evaluated from food conversion ratio (FCR).

Culturing a big population of fish in a pond the change in biomass also takes a sigmoid pattern and can be explained by the same mathematical formula as above. The equilibrium level of biomass is called carrying capacity of the pond. Carrying capacity is defined as thhe standing crop which a pond can support for indefinite period to time. It is desirable to stock

well below the carrying capacity and allow fish population to grow towards carrying capacity. Stocking at a high rate and periodic harvesting so as to keep a gap between standing crop and the carrying capacity allows maximum possible production (Jhingran, 1983).

Selected References

Goldman, C.R. and A.J. Horne (1980). Limnology. McGraw-Hill, Tokyo.
Jhingran, V.G. (1983). Fish and Fisheries of India. Hindusthan Publishing Corpn.
Kormondy, E.J. (1986). Concepts of Ecology. 3rd Ed. Prentice-Hall, New Delhi.
Stickney, R.R. (1994). Principles of Aquaculture. John Wiley & Sons, N.Y.

□

SELECTIVE INDUCTION OF APOPTOSIS IN CANCER CELLS

Gaurisankar Sa
Department of Animal Physiology, Bose Institute
P-1/12 CIT Scheme VIIM, Calcutta 700 054

It has been described earlier that Protein A (PA) of *Staphylococcus aureus* has antitumor and immunostimulatory properties. Protein A also potentites the elicition of various cytokines by the splenic mononucler cells (MNCs). This report describe the P selectively induces apoptosis in Ehrlich's ascites tumor cells (EACs) in Swiss albino mice, whereas it simultneously activtes the prolifertion of splenic MNCs of the same tumor bearers. Protein A inhibited EAC growth and decreased the mortality of the tumor bearing mice. In EACs, the level of bcl-2 protein expression remained almost unaltered, but the level of p53 protein increased singificantly following PA treatment. In contrast, PA had no effect of p53 in splenic MNCs, but it increased bcl-2 expression at the protein level. Thus, it appears that there could be a cross-talk between bcl-2 nd p53 gene expressions. If expression of one gene product is increased, the other either decreases or shows no change. Such cross-talks may be an important factor determining whether a cell would switch on the apoptotic phenomena or not. The present observation is

unique in that : a) no bacterial protein so far showed such a property of activating the immune system in one hand and killing the tumor cells on the other, b) it is indicative of a causal reverse relaationship between bcl-2 and p53 expressions so far as induction of apoptosis is concerned, and c) it raises the possibility of developing such a form of therapy of cancer as would not harm the normal cells of the host.

Over the years; cancer therapy has witnessed many exciting developments. Some studies focused its attention on identifying genes that act as positive and negative regulators of cell growth. Recently, it has also been recognized that the regulation of cell death (apoptosis) is an important modulator of tumorigenesis. Apoptosis has been reported to be the cause of tumor cell death during chemotherapy, radiation therapy and even immunotherapy (1-3). Endogenous biomodulators e.g., interleukins (ILs), tumor necrosis factor-α (TNF-α), interferon-γ (IFN-γ) etc., beyond certain concentrations, may induce apoptosis (4-6). Moreover, killing of tumor cells by antibody dependent cellular cytotoxicity (ADCC), lymphokine activated killer (LAK) cells, and natural killer (NK) cells had also been described to be mediated throug apoptosis (7-9). Nonetheless, selective killing of cancer cells remained as the goal to the cancer research. The major bottleneck in cancer therapy which appeared to be compromising the successes, is the associated systemic toxicity and problems arising out of immunosuppression, primarily due to depletion of normal cells.

Over the past years, our laboratory was engaged in investigating the various properties of Protein A (PA) of *Staphylococcus aureus* (10-21). Protein A acts as an anticarcinogen (13), and also has antitoxic and antitumor properties (14,15). It has strong immunostimultory properties (16-23). It shows increased macrophge phagocytic activity (16), and cuses on increased elicittion of TNF-α, IFN-γ, IL-1, IL-2 etc. (20-23). Recently P has been described as a B cell superantigen that binds B cells bearing Ig receptor (24). In this report we describe, that PA could induce selective apoptosis in Ehrlich's ascites tumor cells (EACs), but does not cause any harm to the splenic lymphocytes of the same host. Our results have also indicated that there exists an interrelationship between bcl-2 and p53 gene expressions at the protein level, which may be the determining factor of induction of apoptotic changes in tumors vis-a-vis normal cells. These observtions for the first time describe that different apoptotic effect could be induced in tumor cells, without hrming the norml cells of the sme host.

To reach to such conclusions, we first investigted the anti-tumor activity of PA. Administration of PA after EAC inoculation decreased the mortlity of tumor bearing mice. After fifth weeks of tumor inoculation, all the control tumor bearing mice were dead, whereas in PA-treated group >75% of the tumor-bearing mice were live. PA also lessened the tumor burden. Simultaneously, number of spleenocytes of the tumor bearing mice was increased by PA treatment by four fold. This implied that PA in one hand is activating the EAC killing, and on the

other it potentiated the proliferation of immunocytes of the host.

We also analyzed the effect of PA on DNA content vis-a-vis cell cycle phases distribution, in both EAC and spleenic cells. In EAC, lower than 2n DNA (hypoploid) was increased as a result of PA treatment. DNA content in S and G2/M phases were proportionately decreased. This suggested breakdown of DNA and the obvious ramifications were on growth arrest of EAC. In contrast, spleenic lymphocytes of EAC bearing mice displayed a typicl partition of cells between G0/G1, S and G2/M phases. however, PA treatment shifted the distribution of spleenic lymphocytes in different indicating differential effects of PA on immunocytes and tumor cells. To identify the nature of cell death, we utlized double labeling studies using flowcytometry to distinguish between apoptotic and necrotic cells. These results indicated apoptosis, not necrosis, is the cause of PA-induced EAC killing.

We took another approach to reconfirm that apoptosis is the cause of EAC death in this model. Unlike in spleenic cells, PA treatment dramatically altered the morphological patterns of EAC nuclei viz. chromatin condensation and blebbing of nuclei and induced DNA fragmentation as was evidenced by DNA ladder formation. These results further indicated that PA induces apoptosis in EAC without harming the spleenocytes.

We next examined the involvement of the tumor suppressor protein, p53, and anti-apoptotic protein, bcl-2, in this system. In spleenic cells, level of p53 expression was extremely low and was not affected by PA at all, but it increased significantly in EAC after PA treatment. In contrast, bcl-2 increased significantly in spleenic cells upon PA treatment. But in EAC the level of bcl-2 was already higher and remained almost unaltered after PA treatment. These results are in conformity with the findings that bcl-2 gene is expressed in high level during normal lymphocyte proliferation and strengthen our data on the mitogenic effect of PA on mice spleenic lymphocytes. Among the genes linked to cancers, bcl-2 and p53 assumes much significance. In fact, bcl-2 is known to bind p53 binding protein and thereby inhibiting the nuclear import of induced wild type p53. Thus, over expression of bcl-2 can interfere with translocation of p53 from cytosol to the nucleus and thereby suppressing the apoptosis inducing effect of p53. It was reported that induced overexpression of p53 cause apoptotic death of tumor cells. Thus opposing and interactive effect of bcl-2 and p53 as has been observed by various workers have relevance with our observations. The novelty, however, of this present observations lies in PA-induced increase in bcl-2 gene expressions in spleenic MNCs of tumor bearers, while increasing p53 expressions in EAC of the same host. Thus, these two genes may contribute to maintain a balance between pro and anti apoptotic reactions. PA increased the level of p53, keeping the level of bcl-2 unchanged in EAC, while totally reverse reactions were seen in spleenic lymphocytes of same tumor bearing hosts.

Since to affect any cellular function or reaction, an exogenous agent must bind and/or intrude the cell, we examined the interaction of PA with EAC as well as spleenic cells.

Interestingly, PA showed high binding affinity for spleenic cells but not for EAC. This gave us the clue to understand that PA does not by itself induce any reactivities in EAC directly.

PA has long been known as an immunomodulator. It induces the production of various cytokines e.g., IL-1, IL-2, TNF-α, IFN-γ etc. from adherent and nonadherent spleenic cells. These cytokines are known as apoptosis inducers. We thus examined whether PA asserts its antitumor activity through such cytokines produced by various spleenic lymphocytes. To address to this question, we investigated the effects of PA on EAC DNA fragmentation and release as was measured by thymidine release from EAC. Thymidine release was observed only when PA pre-treated spleenic lymphocytes were co-cultured with EAC. PA alone could not induce apoptotic effect in EAC in lymphocytes deficient cultures. This indicated that, PA-activated immunocytes are required for EAC killing, probably through cytokine or other apoptotic inducer release and thereby inducing apoptosis.

Such findings also explains why as a result of PA treatment, EACs are selectively killed but not the spleenic cells. It is now clear that PA activates spleenic cells and these activated immunocytes release various cytokines to trigger tumor cell killing activating p53 genes in those tumor cells. The novelty of this observation remains in the fact that PA potentiates the immunocyte proliferation of the tumor bearing host, but induces apoptosis in tumor cells of the same host. This differential effects are caused by differential expressions of bcl-2 and p53 gene products which ultimately determine apoptosis or no apoptosis in tumor versus normal cells.

Selected References

1. Kaufmann, S.H. *et al.* (1993). *Cancer Res.* **53** : 3976.
2. Stephens, L.C. *et al.* (1993). *Radiat. Res.* **135** : 75.
3. Winthrop, M.D. *et al.* (1997). *Cancer* **80** : 2529.
4. Boehm, U. *et al.* (1997). *Annu. Rev. Immunol.* **15** : 749.
5. Mapara, M.Y. *et al.* (1993). *Eur. J. Immunol.* **23** : 702.
6. Sveinbjornsson, B. *et al.* (1997). *Biochem. Biophys. Res. Commun.* **7** : 270.
7. Khar, A. *et al.* (1997). *Cell Immunol.* **177** : 86.
8. Shemtov, M.M. *et al.* (1995). *J. Urol.* **154** : 269.
9. Bright, J.J. *et al.* (1995). *Immunology* **85** : 638.
10. Shukla, Y. *et al.* (1996). *Cancer Lett.* **103** : 41.
11. Ray, P.K. and Srivastava, M. (1996). *Cancer J.* **9** : 221.
12. Kumar, S. *et al.* (1992). *Cancer Lett.* **61** : 105.
13. Bansal, M.R. *et al.* (1989). *Environ. Pathol. Toxicol. Oncol.* **9** : 343.
14. Shankar, U. *et al.* (1993). *Biochem. Pharmacol.* **46** : 517.
15. Subbulakshmi, V. *et al.* (1998). *Biochem. Biophys. Res. Commun.* **250** : 15.

16. Prasad, A.K. *et al.* (1987). *Immunopharmacol. Immunotoxicol.* **9** : 541.
17. Mishra, A. *et al.* (1992). *Immunol. Lett.* **34** : 289.
18. Raisuddin, S. *et al.* (1994). *Int. J. Immunophharmacol.* **16** : 977.
19. Singh, K.P. *et al.* (1992). *Immunupharmacol. Immunotoxicol.* **14** : 79.
20. Paul, B.N. *et al.* (1993). *Immunol. Infect. Dis.* **3** : 295.
21. Prasad, A.K. and Ray, P.K. (1991). *Int. J. Toxicol. Environ. Health* **1** : 101.
22. Catalona, W.J. *et al.* (1981). *Nature* **291** : 77.
23. Ray, P.K. *et al.* (1997). In *Immunomodulation*, pp. 101.
24. Kozlowski, L.M. *et al.* (1998). *J. Immunol.* **160** : 5246.

□

CONCEPT OF REVERSE ENDOCRINOLOGY : ITS APPLICATION IN ANIMAL PRODUCTIVITY

Arun K. Ray
Department of Animal Physiology
Bose Institute, Calcutta 700 054

While classical studies in endocrinology start with identification of a ductless glandular structure and its relationships with the normal functioning of the body after extirpation or abblation, identification of the active principle of the gland and demonstration of its biological function at the cellular and molecular level, the concept of "reverse endocrinology" is based on easy isolation and unambiguous identity of the known biological molecules first in body fluid and then searching its biological function followed by localization of cellular structure of its origin. With the efforts of classical endocrinology the endocrine system as a whole has been understood more clearly in vertebrates than in invertebrates. In otherwords, reverse endocrinology has been well-visualized in invertebrates with the knowledge of available vertebrate endocrinology.

Hormones are messenger molecules. Mostly, structures have been well conserved during evolution. A number of identical or closely similar molecules with hormonal properties have been visualized both in vertebrates and invertebrates. Moreover, evidences show that similar

hormones may fulfil different functions within the vertebrates and, within vertebrates and invertebrates.

Most important incidence for advancement of knowledge and application of reverse endocrinology is the identification of vertebrate sex steroids in invertebrates. Estradiol-17Beta, a vertebrate female sex steroid have been localized in body-fluid of freshwater prawn, *Macrobrachium rosenbergii* and mulberry silkworm, *Bombyx mori* L. Recent studies have indicated indigenous origin of this steroid in both the species and important biological roles related to growth, vitellogenin synthesis, ovarian maturation, stimulation of the general metabolic process and remarkable improvement of some parameters of commercial importance. It is the high time for us to think about applicability of the knowledge of reverse endocrinology to small and commercially important animals to improve productivity.

Selected References

Lafont, R. (1991). Insect Biochem. **21** : 697-721.
Ghosh, D. and Ray, A.K. (1994). Inv. Reproduction and Development **25** : 43-47
Keshan, B. and Ray, A.K. (1998). J. Insect. Physiol. **44** : 491-498.

□

STRUCTURE AND COMPOSITION OF HELMINTH CUTICLE — PRESENT KNOWLEDGE

A.P. Nandi
Department of Zoology, Burdwan University, Burdwan

The term 'helminth', although literally meaning worm, in its usual connotation refers to parasitic platyhelminthes, nematoda and acanthocephala and the study of helminths or Helminthology has come to be regarded as being confined to the study of parasitic forms. The interest of parasitologists in helminth cuticle is due to the demand for information about the role of cuticle in nutrition, the penetration of anthelmintics, immunology, locomotion and moulting.

Cuticle in Platyhelminthes

Before the advant to Electron Microscope (EM) the body surface of Trematoda and Cestoda was believed to be a secreted nonliving cuticle. Examination with the EM has revealed that the body surface of trematodes and cestodes is not covered by a nonliving layer but by a layer of living cytoplasm which is in continuity with large cell-like structures sunk in the parenchyma and the cuticle in these groups is now designated as 'tegument'.

In Trematoda : When studied with EM the tegument is seen to consist of two zones. The outer zone consists of a cytoplasmic syncytium containing mitochondria, endoplasmic reticulum and other organelles. The outer surface is usually thrown into folds to form microvilli which serve to increase the absorptive surface. The outer zone is connected by cytoplasmic bridges to nucleated bodies known as cytons. The cytons, collectively called as inner tegumentary zone, include vacuoles, endoplasmic reticulum, mitochondria, Golgi bodies etc. in addition to nucleus.

In the region between the outer and inner tegumentary zones are found several other types of tissues. Specifically lying immediately medial to the outer tegumentary zone is a thin layer of connective tissue known as basal lamina.

As to the chemical composition of tegument in adult digenean trematode glycogen, nonglycogenic polysaccharides, lipids, acid mucopolysaccharides and mucoproteins have been reported. In addition, several enzymes like Alkaline and Acid-phosphatases, Esterases are detected.

In Cestoda : The tegument is basically the same as that of trematodes. When studied with EM specialised microvilli known as microtriches can be observed projecting from the outer limiting membrane of the tegument. Microtriches, unlike the tegumental microvilli or trematodes, each include an electron dense apical tip separated from the more basal region by a multilaminar plate.

The tegument of cestodes is largely proteinaceous containing certain polysaccharides and glycoprotein. A number of enzymes have been found to be associated with various organelles embedded in the external layer of the tegument.

One of the important features in the tegument of trematodes and cestodes is that the entire surface of the tegument is covered by a 'fuzzy' layer known as glycocalyx seen under electron microscopy. The glycocalyx is a carbohydrate — rich layer consisting of mucopolysaccharides and glycoproteins. As an intergral part of the tegument it undoubtedly plays an important role in the protective, absorptive and immunological properties of the tegument.

Cuticle in Nematoda

The body covering of nematodes is known as cuticle. The cuticle extends into the vagina, excretory pore and rectum. The cuticle is generally smooth, however, various structures such as pines, bristles, warts, punctations, papillae, striations and ridges may be present. The arrangements and positions of such structures are also of taxonomic importance.

The structure of nematode cuticle has long been controversial, especially with regard to the question whether or not it should be regarded as a cell membrane. The nematode cuticle shows considerable diversity in structure, not only between different genera, but even within a single species.

There is no general agreement on the terminology used for describing various layers of the cuticle although there is general agreement that it consists of three layers covered by a triple-layered outer membrane. Based on ultrastructural and cytochemical studies, some authors have concluded that the outer covering is a 'modified cell membrane' and refer to it as the epicuticle. This concept of the outside layer being a cell membrane has been disputed by Wright (1987) who points out that the surface structure is likely to vary considerably in different species as a result of different functional and anatomical requirements. Nevertheless, the term epicuticle now appears to be accepted for the outside layer.

Regarding the remaining layers of the cuticle, there now seems to be agreement that a generalised cuticle would consist of an epicuticle, a cortical zone, a medium zone, and a basal zone which overlies the hypodermis.

The epicuticle shows great morphological variability, with a thickness of 6-49 nm. It appears to consist of glycoproteins and may contain some lipid.

The cortical zone is generally amorphous and electron-dense and its structure varies greatly between species.

The median is not very clear in some species and may be absent in some. It often contains fluid in which there may be fibres, struts or globular material.

The basal zone may be made up of spiral fibres, laminae or striations; a variety of names have been used for these structures. The fibres consist of a collagen-like protein and in Ascaris runs at an angle of 70° to the long axis of the worm. Thus any two sets of fibres enclose a system of minute parallelograms.

Twenty amino acids have been found in the cuticle of several species of nematodes as well as small amount of carbohydrate and lipid. RNA, ascorbic acid, ATP, acid phosphatases and other enzymes have been demonstrated in the cortical zone of Ascaris.

Cuticle in Acanthocephala

The body wall of Acanthocephala is a unique structure completely different from that of other helminths. This consists of a thick tegument which contains a system of lacunar canals.

It consists essentially of five layers, for which various authors have used different terminology. The outermost or epicuticle appears to contain largely mucopolysaccharide presumably equivalent to glycocalyx of cestodes. Beneath the epicuticle lies a tough cuticle perforated by numerous pores which in turn lead into canals and ducts which make up the striped layer. The latter merges into fibrous felt layer beneath which is a radial layer. The radial layer is the thickest of all the layers lacking cell walls but containing nuclei, mitochondria, ribosomes, folded plasma membranes, lipid and glycogen, this layer is probably the most metabolically active part of the body wall. Beneath these layers are a thick basement membrane and circular and longitudinal muscles.

Conclusion

The foregoing is necessarily a generalised account of cuticle based on the limited range of parasitic helminths which has, so far, been readily available to electron microscopists. Whilst the most important ultrastructural features of the cuticle are now quite well-established and have been found to be relatively uniform within each of the major groups of parasitic helminths many particular morphological adaptations which are restricted to smaller taxa and individual species remains to be described and elucidated.

As information on the ultrastructure of the parasitic helminths accumulates, it is inevitable that it will exert an increasing influence on the development of taxonomic systems. This is particularly the case for scanning electron microscope (SEM) studies, and in deed the ultrastructural surface architecture already have a significant role in species discrimination within certain groups of nematodes.

Selected References

Bird, A.F. and Bird, J. (1991). The structure of nematodes. Academic Press, New York.

Cheng, T.C. (1986). General Parasitology. Academic Press, New York.

Hanna, R.E.B. (1994). Ultrastructure of Helminths. In 'Helminthology' (N. Chowdhury and I. Tada Eds.), pp. 160-210. Narosa Publishing House, New Delhi.

Smyth, J.D. (1994). Animal Parasitology. Cambridge University Press.

□

SOME BEHAVIOURAL ASPECTS OF SEXUAL SELECTION

Bikas Channdra Pal
Department of Zoology, University of North Bengal

In 1871 Charles Darwin published "The Descent of Man and Selection in Relation to Sex" in which he considered the complex subject of sexual selection to which he had referred to in his "On the Origin of Species" (1859). Darwin questioned why males and females of the same species often differ so greatly ? He advocated a special process for this i.e. "Sexual Selection" which depends on the advantage that certain individuals have over others of the same sex and species solely in respect to reproduction. Darwin reasoned that females of many species make a definite choice of their sexual partner and that males have acquired specific adornments and courtship displays "not from being better fitted to survive in the struggle for existance but from having gained an advantage over other males and from having transmitted this advantage to their male offsprings alone".

Darwin believed that sexual selection was distinct from natural selection since it operated only through success in achieving matings whereas natural selection operated through success in dealing with other ecologic factors such as obtaining food, avoiding predators, surviving climatic extremes etc. However, we now recognize that sexual selection occurs because of differential reproduction of individuals and their genes and hence is not distinct from natural selection. Indeed, sexual selection is simply a special arena under the over all control of natural selection.

Robert Trivers (1972) expressed the whole gamut of sexual selection in a simple manner in his theory of "Parental Investiment" which suggests that sexual selection will act primarily on the sex investing less, members of which will compete among themselves for access to members of the sex investing more.

In our discussion here we shall continue with the classical terminology as advocated by Darwin because of its traditional popularity. Darwin realized that there are two ways in which a male could gain advantage over other males :

1. They can compete directly with one another by overt fighting or any other suitable covert means i.e. Intrasexual Selection (Selection within a sex).
2. Males can also compete indirectly in attracting females by special displays and adornments i.e. Intersexual Selection (selection between sexes). This type is also called as Epigamatic selection (Huxley, 1938).

Various aspects of the adaptations involved in the intrasexual selection among male such as lowering of mating threshold, Coolidge effect, dominance behaviour, subordinate

behaviour, guarding of mates, interference in competitors mating and direct assault on the competitor is discussed.

Similarly different adaptations involved in intersexual selection or female choice is discussed.

Finally sexual strategies adopted by males and females of various species including Dawkin's Model (1976) is discussed.

Selected References

Alcock, J. (1984). Animal Behaviour. Sinauer Associates Inc. Publishers.

Andersson, M. (1994). Sexual Selection. Princeton Univ Press.

Dugatkin, L.A. and Godin, J.G.J. (1998). How females choose their mates. Scientific Amer. 56-61.

□

SOCIOBIOLOGY OF TERMITTS

P.K. Sen-Sharma

Hony. Scientist, P.G. Department of Zoology,
Presidency College, Calcutta

Sociobiology in animals, in true sense, is a behavioural study which, it is claimed, began in the period in which Charles Darwin (1859) introduced his theories of organic evolution. Behaviour may be instinctive or learned. The concept of instinctive behaviour seems to have arisen in antequity when attempts were made to make a clear-cut definition in respect of differences between man and other animals. It was OE Wilson (1975) who synthesised the concept of sociobiology in his famous book : **"Sociobiology : The new synthesis".**

Social behaviour has highly evolved in insects including termites and these have been grouped under "eusocial" insects. Attributes of 'eusociality' are cooperative participation by individuals in brood care, reproductive division of labour through special reproductive caste with sterile individuals working for the fecund members, and presence of at least two overlapping generations in the life stages so that offsprings assist parents in some periods of their life.

The sociobiology of termites is controlled by castes or polymorphic forms. Polymorphism arose from polyethism. Caste polymorphism and polyethism denotes cooperative behaviour leading to division of labour. The different castes in termites vary considerably in form and fucntion.

Various castes so far recognised in termites are larvae, apterous nymphs, pseudoworkers, workers, presoldiers, soldirs, brachypterous nymphs, reproductive nymphs, alates, adultoids, brachypterous neoteinics, apterous neuteinics, replacement reproductives.

Supplementary reproductives, achristogenics and intercastes

The workers / pseudoworkers constitute the maximum population in any termite colony. Workers functions vary widely. In fact they are responsible for most of works within the termite community and within the nests. The functions include tending of eggs and caring the young once, foraging to gather food, feeding the non-food gatherer members of the colony/community, construction, expansion and repairing of the nest system. It is a marvel of nature that workers of different ages, sizes and sex are allocated different jobs. The study of this is polyethism.

The soldiers as the name signifies are solely responsible for the defence of the colony. In order to perform this vital function, their mandibles and head get modified according to defence methods which range from simple crushing type to highly evolved chemical warfare, other defence mechanisms include snapping, slashing, piercing. The structures of mandibles and head being different in different species are used in taxonomic differentiation up to species level.

The function of reproductives, primary or secondary is solely to reproduce to perpetuate the colony.

The social cohesion (synagonism) which is necessary for smooth colony functioning operates through recognition of nest mates, communication foraging expedition for food gathering, alarming the soldiers for impending dangers etc. These are governed by aggregating pheromones, attraction, trail pheromone, trophallaxis (mutual exchange of nutrients and other material among nest mates), territoriality, inquilism, control of internal environment like temperature and relative humidity, cultivation of fungus garden, aided cellulose digestion through fungal association, regulating the population of dependent non-food gathering castes like soliders etc.

All these have resulted in the development of self regulation of optimal conditions for development, maintenance and reproduction of the society. "self" relates to the society as a whole and not individuals, and the "regulation" refers to the mechanisms that tend to decrease exceess dangers or to amend any deficiency that is inimical to the colony survival and to augment those mechanisms that are conducive for the maintenance of optimal conditions. All these factors led Wheeler (1928) and Emerson (1959) to develop a conceptual frame-work through which they explained the process of natural selection exerting not on any individual or caste but on the entire colony itself (supraorganism). According the supraorganismic concept, functions of workers and reproductives are analogous to those of somatic and germ cells of an organism.

Selected References

Edwards, R. and Mill, A.E. (1966). *Termites in buildings : Their biology and control.* Rentokill, 261 pp.

Harris, W.V. (1971). *Termites - their recognition and control,* Pergamon Press,186 pp.

Hickin, N.E. (1971). Termites : A world problem. Rentokill, 252 pp.

Hertman, H.R. (ed.) *Social insects,* Vols. I-III, Acad. Press.

Roonwal, M.L. (1979). *Termite life and termite control in tropical South Asia,* Scientific Publisher, Jodhpur, 177 pp.

Roonwal, M.L. and Sen-Sarma, P.K. (1966). *Oriental Termities,* 407 pp, ICAR Publ.

Sen-Sarma, P.K. and Tuyen, Vu Van. (1984). *Termites damaging dams and dikes, and their management.* Jugol Kishore, Dehra Dun, 81 pp.

Sen-Sarma, P.K. and Tuyen, Vu Van (1988). *Homeostasis in termite society,* Presidential address, 75th Indian Sci. Congr., Indian Sci. Congr. Assoc., Calcutta, 38 pp.

□

INTEGRATED STUDY OF THE COMPARATIVE FUNCTIONAL ANATOMY — A GLIMPS INTO THE EVOLUTIONARY PROCESS

J.N. Rudra

Professor of Zoology (Retd.), Presidency College

Calcutta

Comparative study of the Functional Anatomy, Phylum wise leads to the proper understanding of the gradual evolution of the group in the perspective of the changing environment. A integratd study of the related and interdependent systems leads to the correct understanding of the "Lavel of Being" to that is of the status and position of the group in the Evolutionary series.

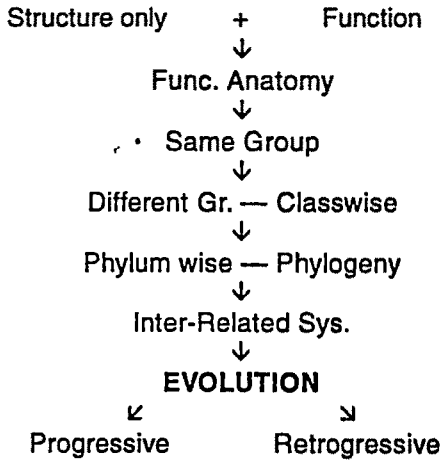
The concept of comparative Anatomy gradually changed to that of the comparative functional Anatomy.

The present discussion is to be developed by a Feed Back system with the Teacher Trainees of this Refresher Course.

Plate-I	Changing Concepts of Comaprative Anatomy
Plate-II	Recapitulation
Plate-III	Primary Impulse - Geotectonic Movement
Plate-IV	Respiratory System
Plate-V	Circulatomy System
Plate--VI	Excretory System

Integrated Comparative study of the three Cardinal Systems, Respiratory, Circulatory and Excretory systems thus reveals the uniformity of the Evolutionary process giving a better understanding of the mistry of Evolution.

I. CHANGING CONCEPTS OF COMPARATIVE ANATOMY

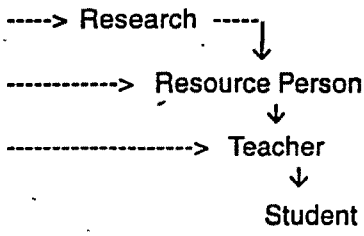


II.

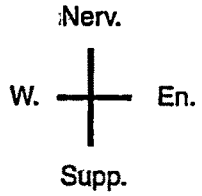
- KEY WORD - What, Why, Whom, How, How-Mutch
- KEY ALPHABETS - M.S.C.
- GUIDE WORD - P.R.O.J.E.C.T.
- CHECK WORD - R.S.V.P.

--> R - Relevance, Reception
S - Significance, Speed
V - Volume, Value
P - Pronounciation, Purpose
(Short & Long term)

- CONTINUOUS FEEDBACK SYSTEM



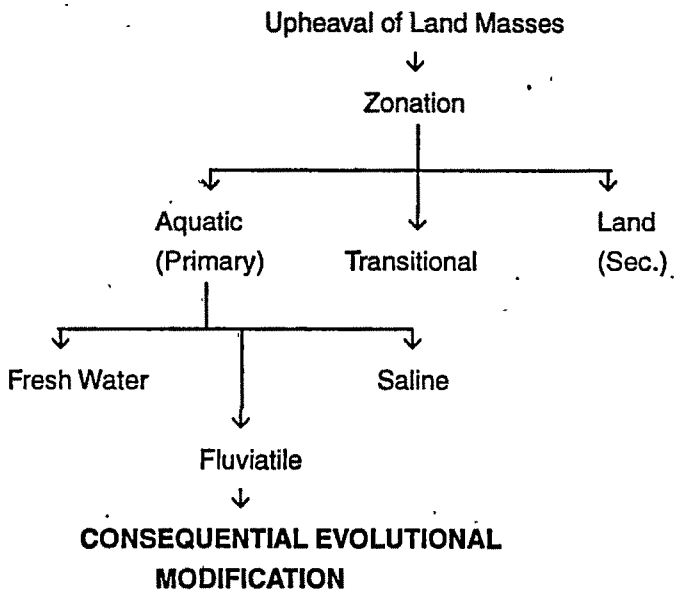
- Cardinal Systems



III. Primary Impulse

GEOTECTONIC MOVEMENT

Result —



CONSEQUENTIAL EVOLUTIONAL MODIFICATION

CHANGE OF BLUE-PRINT

IV. RESPIRATORY SYSTEM

PRIME FACTOR - Medium containing oxygen

1. Water — ↑ of Surface of Absorbation
   i) Gill - Pouch ii) Gill

2. Air — ↑ of Surface of Exchange (Lung)
   Actual Virtual

- Septa - Amphibia, Reptilia
- Alveoli - Mammalia
- Channel - Avis

- Consequential modification of Respiratory - Mechanism

V. CIRCULATION

I. Heart

KEY-NOTE : A. Condensation
  i) Re-orientation
  ii) Absorption
  B. Differentiation

RESULT : 1. Primary Heart - Fish
  2. Transitional - Amph., Rep.
  3. Sec. Heart - Birds, Mam.

II. Aortic Arches - Condensation
  Differentiation

III. Mechanism of Circulation

Single -----> Double

IV. Functional Modifications

- Oxygen transport capacity
- Electrolyte Balance

VI. Excretion

Zonation & Structural differentiation

---> Pro-nephros
Meso-nephros
Meta-nephros

---> Malpighian Corpuscles & Nephric tubules

Function :

- Osmoregulation
- Electrolyte balance
  - Stenohyal
  - Urohyal

Mechanism

1. Pressure Filtration
2. Selective Reabsorption

□

NEMATODE PARASITES OF PLANTS, THEIR INTERACTIONS WITH HOSTS AND CONTROL

N.C. Sukul

Department of Zoology, Viswa Bharati, Santiniketan, West Bengal

Nematode parasites attack almost all kinds of plants and are important pests of field and fruit corps as well as forest trees. Very often they form disease complexes with other pathogens like, viruses, bacteria and fungi. Some common plant parasitic nematodes with their hosts are mentioned below.

1. *Meloidogyne incognita* : Vegetables
2. *Heterodera rostochiansis* : Potato

3. *Anguina tritici* : Wheat
4. *Hirschmaniella mucronata* : Rice
5. *Tylenchulus semipenetrans* : Citrus plant
6. *Aphelenchoides bessevi* : Rice

Pathogenicity

Plant nematodes are responsible for 10-14% loss in crop yield depending on nematode population, soil moisture, soil temperature, soil microfauna, microflora and soil nutrients. Infected plants show stunted growth and certain symptoms characteristic of nematode species involved. As for example, *M. incognita* causes root galls. The 2nd stage larvae of this nematode penetrate epidermis near root-tip and come to stele. Here the larvae pour oesophageal secretion into cells through their odontostyle. The cells undergo redifferentiation becoming much larger in size and multinucleate. The permeability of the cell walls also undergo a change. These giant cells are known as transfer cells which connect xylem and pholem and provide nourishment to developing nematodes. The transfer cells contain high amount of protein, DNA, RNA and IAA. Lipids and carbohydrates are reduced in amount in these cells. The 2nd stage larvae undergo 3 more moultings to became mature females which lay eggs in egg-sacs. Mature females protrude outside the root. Life cycle is completed in about 30 days. Males do not feed on roots. Reproduction occurs mainly by parthenogenesis.

Nematodes as virus vectors

Nematodes also serve as vectors for viral diseases of plants. Plant viruses transmitted by nematodes are of two kinds, namely, NEPO or nematode transmitted polyhhedral virus and NETU or nematode transmitted tubular virus. DEPO viruses are transmitted by species of *Xiphinema* and *Longidorus* while DETU viruses are transmitted by species of *Trichodorus*. Viruses are sucked by nematodes from infected plants during feeding on plant juices. They adhere to the wall of the lumen of oesophagus, remain viable for months in the vector and are transmitted to the healthy plants when the nematodes feed on them.

Control

Control measures for plant nematodes involve (1) crop rotation, (2) hot water treatment, (3) soil solarization, (4) chemical nematicides, (5) botanical campounds, (6) Interplanting which antagonistic plants and (7) biological control. Chemical nematicides liké aldicarb, furadan, DBCP, EDB, DD are effective but cause environmental pollution including contamination of ground water and depletion of stratospheric ozone. They also leave toxic residues in edible parts of plants. Botanicals are relatively safe and easily biodegradable. Interplantings are also effective but the cover crops should be compatible with the main crop in the agroecosystem. Biological control with

nematode trapping fungi, carnivorous nematodes, tardigrades, free-living flat worms is still at experimental stage.

Gene experession

Invasion with plant nematodes results in the expression of certain genes in the host plants. These genes produce specific proteins, namely pathogenesis related proteins or PR proteins and proteinase inhibitor proteins or PI proteins These natural defense responses in the host plants are systemic in nature.

Selected References

Thorne, Gerald (1961). Principles of Nematology. NY., Mc-Graw Hill Co.

□

THE LEISHMANIASES : A CHANLLENGE

A. Nandy

Professor of Protozoology, Calcutta School of Tropical Medicine, CAlcutta 700 073

Leishmaniases, a complex of diseases caused by several species of the genus *Leishmania* has been known to be worldwide in its distribution in the tropical and sub-tropical countries. Successful infection by these parasites may lead to pathology in three broad anatomical sites namely skin, mucus membrane and viscera thus leading to diseases such as cutaneous, muco-cutaneous and visceral leishmaniasis respectively. Leishmaniases has now been considered as one of the important killer diseases of man and has gained further importance as one of the opportunistic infection associated with immunosuppression following HIV infection as well as other infective and non-infective causes. Inspite of significant scientific knowledge, Leishmaniases has now thrown greater challenge than ever before.

The disease in India, has been known to exist for more than 160 years now although the causative agent was discovered in the year 1900. In India, Kala-azar has been known to appear in epidemic waves. Periods of disease outbreaks followed by almost disease free periods. The out-

break of 1940s and 50s were brought down to control after the National malaria eradication Program (NMEP) was launched in 1956, so much so, that not only the people but also the medical practitioners forgot about the disease. It was in the year 1970, in 4 districts of North Bihar, a serious outbreak of Kala-azar was noticed and then the disease gradually spread to other districts of Bihar and also to West Bengal. At present 13 districts of West Bengal have been affected by the disease.

The Parasite

Genus *Leishmania* was created in the year 1903 by Ross after the name of Sir William Leishman. In the year 1900 William Leishman discovered *Leishmania donovani* in spleen smear of a soldier who died from fever contracted at Dum Dum, India, known as DumDum fever or Kala-azar. His observations were published in the year 1903 in which year Charles Donovan found the same parasite in smear of spleen puncture of another patient. Leonard Rogers (1904) first succeeded in culturing the parasite and showed that flagellated form develops in cultures. Paton (1907) proved that the amastigote stage could be found in wandering histiocytes in the peripheral blood and that promastigote forms occurred in the intestine of insects fed upon Kala-azar patients.

Leishmaniae are unicellular prototozoa and exist in two morphological forms, i.e., amastigotes (L.D. bodies) present in the vertebrate host and a flagellated promastigote present in the culture medium and in the insect vector. The parasite in the amastigote stage is obligatory intracellular while the promastigotes are extracellular. The amastigotes are ovoidal bodies of 2-3 µm in length with a round or oval nucleus and a rod-shaped kinetoplast. With Giemsa or Leishman stain the nucleus and the kinetoplast stain red, and the cytoplasm stains faint blue. In cultures the promastigote forms are elongated, spindle -shaped and motile with a single flagellum. They measure 15-25 µm in length and 1.5-3.5 µm in breadth, the flagellum measures about 15-28 µm in length. The natural habitat of the amastigotes is the mononuclear phagocytic cells (the histiocytes) of the reticulo-endothelial system (RES) in the vertebrate host and that in case of promastigotes is the intestine of the vector sandflies. However, it is not fully known how the parasites could survive in the cell which are actually meant for their clearence thus posing a challenge. The answer to this question is of tremendous applied importance in the form of drug development.

The life cycle of the parasite is completed in two hosts, i.e., a vertebrate host and an invertebrate host (Fig.1). The amastigotes which are intracellular, multiply by binary fission in the macrophages until it reaches an optimum number to rupture the host cell and then invade fresh macrophages for further growth and multiplication. To begin with, the kinetoplast first divides into two followed by mitotic division of the nucleus. The vector sandflies during their blood meal pick up parasitised macrophages which in the mid gut of the insect liberates the amastigotes. These amastigotes may sometime divide not more than once to amastigote and subsequently transform and multiplies into the flagellated, motile promastigote form. The promastigotes after 4-5 days of

development and multiplication within the blood meal surrounded by the peritrophic membrane, come out in enormous number and migrate anteriorly towards the fore gut and accumulate at the base of the proboscis in the pharynx and hypostome blocking both these parts. After 5-7 days of an infective meal the sandfly acquires the infectivity. Following an infective bite these promastigotes are ejected into the subcutaneous tissues of vertebrate host including man, by the sandfly to get rid of the block, thereby facilitating blood sucking, where they are quickly taken up by the locally available phagocytic macrophages. During the process of phagocytosis the promastigotes shed their flagella and become amastigote in the cytoplasm of the host cell. Following local multiplication in the subcutaneous tissue, the parasites disseminate to other organs and lymphatics and thereby spread infection.

The Vector

Several species belonging to the genus *Phlebotomus* and *Lutzomyia*, are considered to be the vectors of Leishmaniases, although there is a great deal of variation in the availability of species in different geographical regions.

The Disease

The following is a description of different species of the Leishmania and the diseases they produce.

Leishmania donovani complex :	Causative agent of visceral leishmaniasis of kala-azar and post kala-azar dermal leishmaniasis (PKDL). The parasites are *L. donovani; L. infantum* and *L. chagasi.*
Leishmania mexicana and *Leishmania brasiliensis* complex :	Causative agent for new world cutaneous and mucocutaneous leishmaniasis (Espundia; Uta; Chiclero ulcer etc.)
Leishmania tropica and *Leishmania major* :	Caustive agent of cutaneous leishmaniasis or Oriental Sore.

In India, two forms of Leishmaniasis exist, namely, (1) those caused by *L. donovani*, Visceral leishmaniasis of kala-azar, Lymphatic leishmaniasis and post kala-azar dermal leishmaniasis (PKDL) and (2) those caused by *L. major* & *L. tropica*, the disease being the Cutaneous Leishmaniasis or Oriental Sore.

However, geographical distributions of these two forms are well demarcated in India without any overlapping and are influenced mostly by environnemtal and climatic conditions, like type of soil, relative humidity and temperature range, which in turn determine the availability of appropriate vector species. While kala-azar is prevalent in the areas having alluvial soil wih high sub-soil water level providing adequate humidity for the sandfly to breed in the Eastern and South-Eastern

provinces, the Oriental Sore has been restricted to the Northern and North-Western States having dry and arid climatic conditions, providing appropriate breeding micro environment to the vector sandflies. Besides, the Oriental sore may be both anthroponotic as well as zoonotic (as in Rajasthan). In case of the Zoonotic Cutaneous Leishmaniasis in India, field rats act as the reservoir hosts and the rodent burrows provide an ideal microenvironmental condition of the breeding of the sandflies, thus maintaining the rat to rat transmission ongoing. Man gets the infection by coming close to the rat burrows, the classical example being the outbreak of Cutaneous Leishmaniasis during the digging of the India Gandhi canal in Rajasthan.

Immunology of Kala-Azar

Depending upon its nature and extent, the outcome of the host - parasite interaction in *L. donovani* infection has been known to exist in the form of a clinical spectrum (Fig.2). While *L. donovani* infection on one hand may persist as inapparent infection without any clinical manifestation, in the other hand Kala-azar represents the other extreme pole, where in the host completely fails to restrict the growth and multiplication of the parasite leading to total suppression of CMI and thus the disease. The main feature of the immune response in kala-azar is a highly stimulated humoral immune response (B-lymphocyte) producing incredible amount of antibodies and at the same time failing to stimulate the cell mediated immune response. As a result, the immunocompetent T-lymphocytes cannot recognize the presence of the parasite in the host tissue which multiply freely inside the phagocytic cells like macrophages. Paradoxically, inspite of their presence in huge amounts, the antibodies cannot protect the person from the disease because of their failure to kill the intracellular parasites.

Laboratory diagnosis

In the laboratory, Leishmaniases may be diagnosed on the basis of either demonstrating the parasite or by demonstration of antileishmanial antiboty, by using the following methods. The parasites may be demonstrated in the smear from bone marrow, splenic aspirate, skin smear, lymph node smear or may be isolated in NNN medium to demonstrate promastigotes. Newer DNA based techniques may also be used to demonstrate parasitic component. Serological methods include : direct agglutination test (DAT); indirect fluorescent antibody test (IFAT) or ELISA and other non-specific method like Napiers formol gel or aldehyde test.

Evolution of Epidemiological Forms

Although kala-azar was first recognized as a distinct disease entity in India, yet the Indian type is considered as the most atypical because of being purely anthroponotic. It has been observed that there are several different life cycles of the diseases each related to different epidemiological and clinical forms. All these cycles when arranged in sequence, suggests that visceral leishmaniasis actually evolved from an enzootic disease through series of intermediate

steps (Fig.3) to purely anthroponotic disease where man and vector are the only hosts. With continuing evolutionary processes it remains a matter of challenge, how long India may retain the purely anthroponotic nature of kala-azar and would be able to prevent transformation back to zoonotic situation.

Vaccine development

Till date successful vaccination has only been possible against cutaneous leishmaniasis, which as such is a self limiting disease. What would be more challenging is to develop vaccine against visceral leishmaniasis (kala-azar). Although significant work has been done on protective immunity in kala-azar, actual mechanism of the immune response that lead to protective immunity has not yet been fully understood. Until that, vaccine against kala-azar remains a achallenge.

Selected References

Beaver, P.C., Jung, R.C. and Cupp, E.W. (1984). Clinical Parasitology, 9th Edition, Lea and Febiger, Philadelphia.

Manson-Bahr, P.E.C. and Apted, F.I.C. (1982). Manson's Tropical Diseases. 18th Edition, Bailliere Tindall, London.

Nandy, A., Addy, M., Chowdhury, A. and Ghosh, A. (1988). Current situation of visceral leishmaniasis in India with special reference to West Bengal. Proceedings of the International Workshop on Control Strategies for Leishmaniasis. (01-04 June 1987) Ottawa, Canada, pp. 8-15.

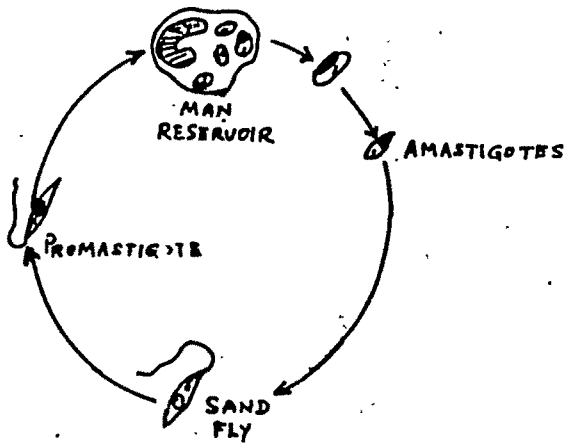
Nandy, A. and Chowdhury, A.B. (1988). Lymphatic leishmaniasis in India. Trans. Roy. Soc. Trop. Med. Hyg. **82** : 411.

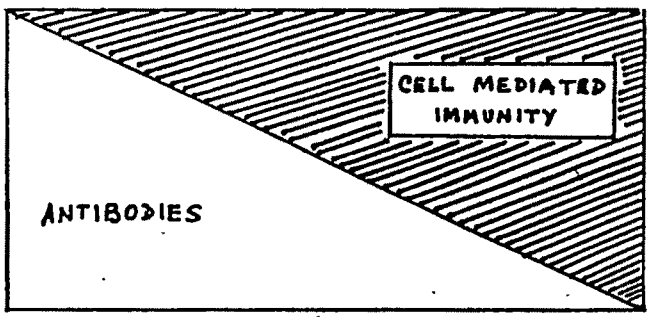
World Health Organization (1990). Control of Leishmaniasis. Technical Report Series No. 793, WHO, Geneva.

□

KALA-AZAR : FIG 1.

- A DISEASE OF THE RE SYSTEM (IMMUNE SYSTEM)
- PARASITE L. donovani
- VECTOR - SANDFLY.



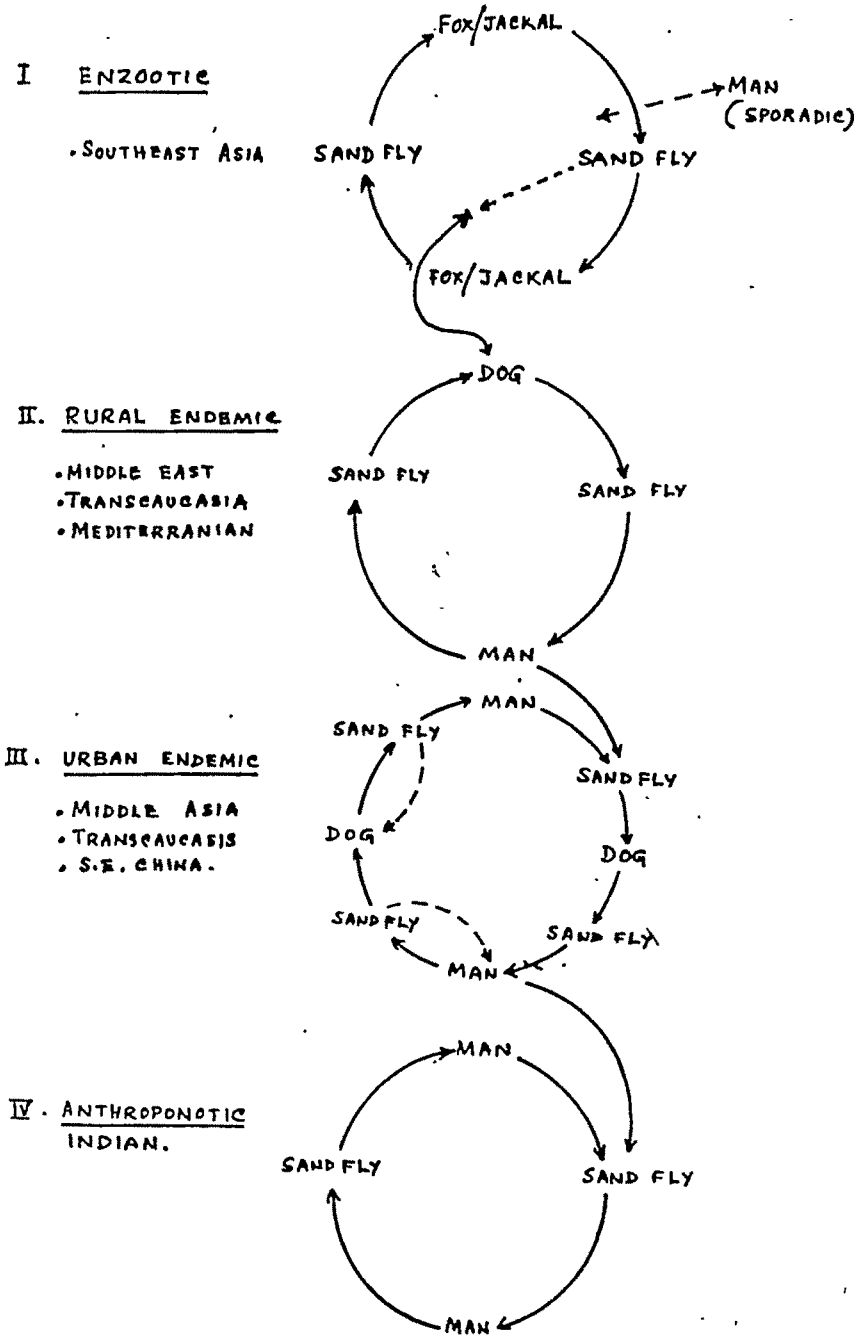


DISEASE (KALA-AZAR)
SPLENOMEGALY
PANCYTOPENIA
HYPERGLOBULINEMIA

Fig. 2- SPECTRUM OF LEISHMANIASIS

ASYMPTOMATIC
SKIN TEST +VE
PROTECTIVE IMMUNITY.

EVOLUTION OF EPIDEMIOLOGICAL TYPES OF LEISHMANIASES
Fig. 3.



MALARIA : CURRENT SITUATION & CONTROL

A. Nandy

Professor of Protozoology, Calcutta School of Tropical Medicine

Following countrywide anti-malaria activity in the form of National Malaria Eradication Programme (NMEP) incidence of malaria was brought down from 75 million cases to merely 50,000 in the year 1961. Following this phenomenal success, however, there was gradual resurgence of the disease and in the year 1976 the incidence went up to 6.4 million. Such resurgence has been attributed to : (1) lack of mass surveillance as a strategy under NMEP, (2) development of DDT resistance by the mosquitoes, (3) emergence and spread of chloroquine resistant *P. falciparum*, (4) rapid development/urbanization without taking into consideration the creation of malariogenic conditions and (5) gradual disappearance of malaria workers and knowledge.

Currently malaria is considered as India's one of the most important health problem and the entire country has become endemic. However, there are provinces and areas which are considered as high risk areas for malaria and more importantly drug resistant falciparum malaria. The city of Calcutta has been considered among the list of high risk areas as far as falciparum malaria is concerned. In West Bengal, however, apart from Calcutta, three more districts are of great malariogenic significance and they are Jalpaiguri, Coochbihar and Purulia.

Malaria is a disease manifested by periodic fever with or without chill and rigor, caused by the asexual multiplication of protozoan parasite of the genus *Plasmodium* in the blood stream and is transmitted by the bite of infected female anopheline mosquito. There are four species of malaria parasites that infect man namely, *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae*. Out of all the human malaria parasites, *P. falciparum* is the most virulent and is responsible for all varieties of complicated malaria and death. Resistance to antimalarial drugs has also been a feature of *P. falciparum*.

In India *P. vivax* is the predominant species and *P. falciparum* is th second most, although there are pockets of *P. malariae* in Northern and North-eastern areas. In the recent past there has been an alarming increase in the incidence of falciparum malaria in certain parts of the country.

The Biology and Life Cycle of Malaria Parasites (Fig.1)

The malaria parasite completes its life cycle in two hosts, the insect vector (mosquito) and the vertebrate host (man). The parasite has two types of multiplications, a sexual and an asexual (schizogony). The entire asexual cycle is completed in the vertebrate host. While the process of sexual reproduction (gametogony) begins in the vertebrate host, the actual fertilization and subse-

quent development takes place in the invertebrate host. man gets the infection either through bites of infected female anophiline mosquito injecting sporozoites or in occasional cases through blood transfusion containing the asexual stages. The incubation period of mosquito induced malaria in man may be 8-45 days. After entry in man, the sporozoites within 45 minutes time enter the hepatic parenchymal cells and multiply by schizogony (exoerythrocytic schizogony). On maturation the infected cell ruptures releasing the merozoites which enter the blood stream to infect RBCs. In the blood stream, the erythrocytic schizogony is completed every 48 hrs in cases of *P. falciparum*, *P. vivax* and *P. ovale* and 72 hrs for *P. malariae*. Excepting the *P. vivax* the *P. ovale* parasites, the exoerythrocytic cycle ends with the beginning of the erythrocytic stage. However, in cases of *P. vivax* and *P. ovale*, some of the sporozoites remain dormant in the liver for a specified period of time after which they again start the liver cycle, mature into merozoites, enter into the blood stream and initiate a fresh bout of clinical malaria, i.e. the true relapse. This stage of the parasite, remaining dormant in the liver, is known as hypnozoites. Because of the absence of hypnozoites, the falciparum malaria does not relapse.

Each erythrocytic schizogony through the stages of trophozoites and schizont, ends up in the formation and release of erythrocytic merozoites along with their toxic and pyrogenic metabolites. Thus the rupture of mature schizont after each cycle coincides with the appearance of fever and clinical malarial attacks. After 2-3 erythrocytic schizogonic cycle some of the merozoites differentiate into male and female gametocytes. However, the gametocytes once developed, do not multiply further in the blood stream unless they are taken up by the mosquitoes and therefore are unable to rupture the infected RBC to release the pyrogen which in turn is unable to febrile clinical attacks of malaria. The gametocytes are never responsible for malarial attacks and usually die (natural death) within an average period of 6-8 weeks.

In case of transfusion malaria, the cycle starts immediately in the blood stream and therefore, the incubation period may be as short as one day. Howver, due to absence of sporozoites and hence hypnozoites, transfusion malaria does not relapse.

Following an infected blood meal, in the mosquito stomach 6-8 microgametes develop from each male gametocyte and female gametocytes develop in to one macro gamete. After fertilization through the stages of zygote, ookinete and oocyst, by sporogony, sporozoites are developed which after rupture from the oocysts migrate to penetrate the salivary gland to make the mosquito infective after the extrinsic incubation period which varies in between 8-20 days depending upon the environmental temperature.

The Disease Pathogenesis and Pathology

Clinical attacks of malaria are basically due to asexual multiplication of the parasites in blood and release of the merozoites from the infected RBCs. As long as the parasite develop in the liver there would be no clinical signs or symptoms.

Incubation period in malaria includes the period from entry of sporozoites till the parasites multiply in blood after passing through the liver stage, and attain a critical number to produce fever. The intensity of fever and severity of the disease are vastly dependent on the number or load of asexual parasites in blood.

It is to be noted that, except *P. falciparum*, no other human malaria parasites have the ability to produce severe or malignant form of the disease. *P. falciparum* parasites complete schizogony in the lumen of small capillaries of different organs. Falciparum parasites produce and secrete certain molecules which after being thrown out, stick on to the membrane of both parasitised as well as unparasitised red cells, in addition to the endothelial cells, imparting a sticky character. As a result of acquiring adhesiveness RBCs form microclumps in the blood stream, which blocks the blood flow through the small capillaries. This blockage results into loss of blood supply to the tissue, resulting in cell death due to anoxia. Such anoxia becomes very harmful to the vital organs, like brain which results into the condition known as "Cerebral Malaria". Similar damage in intestine results in loss of absorptive surface, leading to diarrhoea and haemorrhage, and in lung causes pulmonary oedema. The situation is further aggravated by stimulation of tumor necrosis factor (TNF) and production of nitric oxide.

Clinical Types

Clinically malaria is classified into two types, (i) simple uncomplicated and (ii) severe and complicated malaria. It is to be noted that unless associated with underlying other diseases, all severe and complicated malarias are caused by *P. falciparum*. The disease is manifested and accompanied by fever with chill and rigor, which generally occurs at 48 or 72 hrs interval, corresponding to the completion of asexual schizogony and release of mature erythrocytic schizonts. However, if there are multiple broods of parasites then the fever may appear daily or irregularly. Severe anaemia, jaundice, unconsciousness, convulsion, diarrhoea, bleeding from nose, gum, skin and intestine, breathlessness due to pulmonary oedema, are all signs of a grave and complicated malaria and if not attended promptly, results in death of the patient.

Laboratory Diagnosis

Peripheral blood smear examination is the method to diagnose malaria. However, both thick and thin smear preparations must always be examined to confirm the diagnosis. While thick smear is 20-25 times more sensitive than thin smear, species confirmation is ideally made by thin smear examination.

There has been some misconception about the time of collection of blood. It is advised that blood for examination of malaria parasite, **can be collected any time in the day and night irrespective of the presence of fever**. Under certain circumstances, because of low parasite count, a blood smear may not yield positive result even with thick smear. In such cases it is advised that the smear of blood from the patient should be collected every 6 hrs for 36 hrs. Alternatively, a negative report of blood examination once daily consecutively for three days, almost rules out malaria.

Immunology

Although both cell mediated as well as antibody mediated immune response are stimulated, it is the antibody production which is more important not only for protection but also for decreasing the intensity of infection, severity of the disease and influencing its epidemiology. However, the antibodies produced, are not only species specific but also stage band strain specific. The *P. falciparum* parasites may undergo antigenic variation *in-vivo*, thereby preventing the lethal effect of antibodies produced stimulation during earlier infection, which in turn can cause reappearance of asexual parasitaemia and clinical malaria known as "recrudescence". However, in endemic areas, recrudescence is almost impossible to differentiate from re-infection.

Although several types of malaria vaccines have been developed and tested, but because of antigenic diversity, they are of little practical importance, recently synthetic peptide vaccine develped, shows around 30% protection. Large scale field trials are undergoing and the results are expected soon.

Control Measures

Malaria control can only be achieved by a multi-disciplinary approach. Of primary importance are (1) parasite elimination by early diagnosis and prompt treatment, (2) vector elimination by anti adult and antilarval measures, (3) peoples awareness and participation, (4) elimination of malariogenic conditions.

Vector elimination by reduction of artificial source of collected water, that serves as breeding ground for mosquito. This can be achieved by people's awareness, health education and by imposing laws. Even if eradication of malaria is not possible, by appropriate measures mortality can definitely be reduced to an insignificant level.

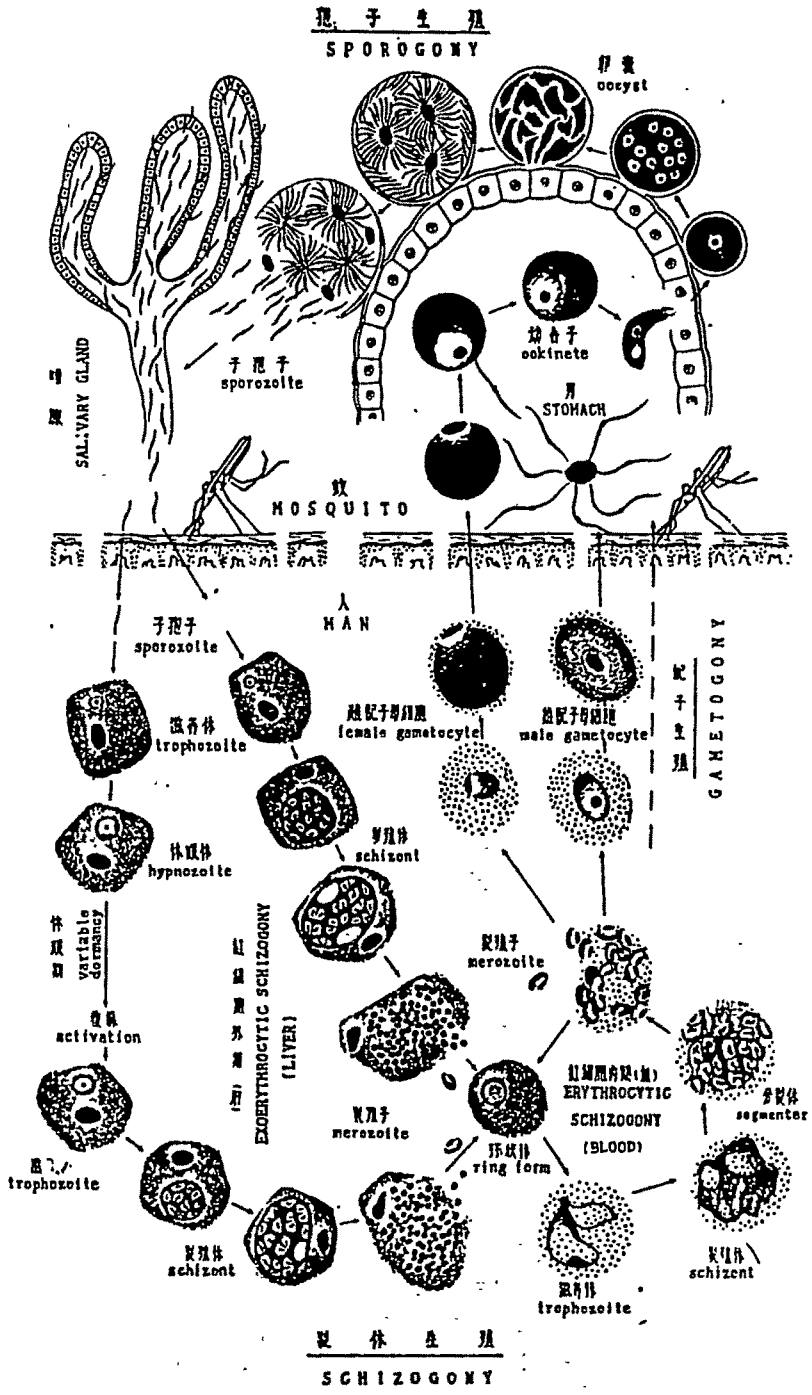
Selected References

Gills, H.M. and Ward, D.A. (1993). Burce-Chwatt's Essential Malariology, 3rd Edn.

National Malaria Eradication Programme (1995). Operation Manual for Malaria Action Programme (MAP). N.M.E.P., New Delhi.

World Health Organization (1990). Practical Chemotherapy of Malaria. Technical Report Series No. 805. WHO, Geneva.

□



間日疾原虫生活史圖解

Fig. 1. LIFE CYCLE OF PLASMODIUM VIVAX

MOLECULAR PHYLOGENIES & EVOLUTION

R.K. Poddar
Former Vice-Chancellor
University of Calcutta, Calcutta

Until recently, comparative studies of closely related organisms in various geological periods as revealed in their fossil records provided major methodological tools for investigations into the process of biological evolution. Although the overwhelming similarities of underlying biochemical and biophysical processes point towards a common ancestry of all present-day living orgnisms, classical methods of study of biological evolution do not provide data leading to any plausible explanation as to how this might have actually happened. Recent advances in molecular biology enabling as to compare the nucleotide sequences of DNA and RNA and the amino acid sequences of proteins have led to the development of a powerful methodology to investigate phylogenetic evolution at the molecular level since the origin of life. One of the most surprising results of such comparative studies on ribosomal RNA is the emergence of the "Three-Domain" model — the Eucarya, the Bacteria and the Archea — of biological evolution, as proposed by Carl Woese. Another notable contribution of such studies is the conclusive evidence of endosymbiotic origins of mitochondria and chloroplasts. Using concepts such as, "molecular clocks" and "evolutionary distances" phylogenetic "trees" of evolving genes and proteins of widely diverse species can now be constructed with the help of various computer programs.

Selected References

Strickberger, M.W. (1995). *Evolution* (2nd Ed.). Jones and Barlett Publisher Inc., USA.
Li, W-H, and Graur, D. (1991). *Fundamentals of Molecular Evolution.*

Natural Resources in Sunderbans

Pranabes Sanyal, I.F.S.
Department of Environment, Govt. of West Bengal
4, Fairlie Place, Calcutta 700 001

The Sunderbans National Park has since been declared a World Heritage site considering its vast mangrove area furnished with largest species diversity of mangals. The faunal diversity with rhythmic behaviour pattern flowering in 1431 species is also a unique feature of Sunderbans. Apart from this mangrove tigerland's rich endemic genetic resource, the resources of Sunderbans may be classified as below :

1. Forest Resources
   - Major Forest produce
   - Minor Forest Produce
2. Fishery resources
   - Fish
   - Shell fish
   - Edible algae.
3. Tourism resource

It should also be kept in mind that entire coastal fishery of East India down to Andhra Pradesh gets the input from Sunderbans Mangrove forests which act as nursery, breeding and feeding ground, etc. for 90% of coastal aquatic fauna.

Forest Resources: Sunderbans Forests on the Indian side represent less of freshwater influence. As a result the occurrence of *Heritiera* and *Nypa* is restricted mostly on east of river Matla. The volume yield of trees are also more on eastern portion.

The east of Matla river has been declared as Sunderbans Tiger Reserve with an area of 2585 km2 and the west is 24 Parganas Forest Division over about 1600 km2 area. **Average annual out turn** as revealed from data of Ist Working Plan stands as follows:

- 24 Parganas division: 0.22 m3/h (timbers) + 0.45 m3/h (Fire Wood)
- Sunderbans Tiger Reserve 3.02 m3/h (Timber) + 0.63 m3/h (FW)

The onsite use of Sunderbans mangrove trees may be as follows:

1. Fuel wood from most of the mangroves are high in calorific values, *Avicennia* and *Rhizophora* are good for brick burning.
2. Charcoal is produced mainly from *Rhizophora* and rarely from *Bruguiera*
3. Alcohol is produced from *Nypa*-palm
4. The timber is produced from mangrove plants as below:
   - Construction timber form *Bruguiera, Heritiera, Ceriops, Xylocarpus*
   - Poles are produced from *Ceriops, Lumnitzera* (Teredo-resistant), *Bruguiera*
   - Planks are produced from *Sonneratia, Xylocarpus*
   - Turnery works are done from woods of *Xylocarpus granatum, Amoora cucullata*
   - Match wood in derived from *Excoecaria*
   - Pulp is produced from *Excoecaria/Rhizophora*
   - Boats are constructed from *Heritiera, Xylocarpus*
5. Good quality thatch is produced from the leaves of *Nypa*-palm

Proposed yield calculation: The proposed yield calculation in the last Revised Management Plan is as follows:

Proposed revised core area =	1699.502 sq.km.
Buffer area = (2584.77 sq.km. - 1699.502 sq.km.) =	885.27 sq.km.
Non-sanctuary buffer zone = (885.27 - 362.33) =	522.94 sq.km.
Available exploitation area =	522.94 sq.km.
Less 5% as erosion buffer =	26.16 sq.km.
Net cultivable area =	496.78 sq.km.

Therefore, annual felling area on a felling cycle of 20 years is as follows:

49678 ha./20 =	2484 ha.
i.e. Rough weather coupe =	1242 ha.
Fair weather coupe =	1242 ha.

As before, the rough weather coupe should be laid on the northern portion during June-September and fair weather coupe on the southern portion during October-March.

The felling regulations are as follows:

The annual coupes should be divided into two parts:

- Rough weather coupe and
- Fair weather coupe
- During rough weather, coupe should be more on northern side.

Selection felling is carried out Genwa trees upto 5 cm. BHG should be retained. Passur, Sundari and Keora trees should not be felled.

After the coupe is laid out the first lot workers would be allotted equivalent section squares to work for timber The firewood permit holders would work in the same section after harvest of timber.

Dry fuel may be allotted to local villagers only for local consumption from the lops and tops of worked out coupes.

In 24 -parganas Forest Division the annual yield is 1000 ha.

Since last year the felling of annual coupe is totally stopped following a Supreme Court of India directive.

Joint Forestry Management: Of late since 1995, participatory forest Management has taken start in Sunderbans. The concept of people's participation succeeded in southern Bengal and the labour-master relationship has changed to Joint ownership concept. Forest Protection committee (FPC) are formed with local participation FPCs manage a dedicated forest area with the technical and minor financial inputs from Government. They are allowed to harvest the Nonwood Forest Produce (NWFP) like honey, medicinal plants, fruits etc. The major Forest Produce is harvested at the end of felling cycle and 25% of usufructs are distributed to the FPCs.

In case of management of Sanctuaries and National Parks the dedicated Forest area is managed by Eco Development Committee (EDC). In case of EDCs no usufruct of major forest produce is allowed. Alternate employment is arranged in lieu of participation.

Till 1998 following FPC and EDCs have been formed to manage about 1000 km^2 of forest area:

- Sunderbans Tiger Reserve: 10 FPCs + 12 EDCs consisting of 10, 000 families.
- Twenty four Parganas Forest Division: 21 FPCs consisting of 8300 families.
- This JFM project was funded under World Bank assistance.

Principal motivation of the local people is the safety against high gales ensured by the maintenance of the mangrove forests in Sunderbans. Results had been encouraging. **The total area of Dense Mangrove forests have increased during last five years from 1952.87 km² (1989) to 1963.42 km² (1995) mainly due to increased natural regeneration** as a result of less disturbance to the system. This is an indicative direction towards *sustainable management* of forest resources of Sunderbans.

Achievment: The results of the JFM in Sunderbans, if assessed quantitatively, will indicate the following:

Increase in 'Area of Workable Dense mangrove' per year = (1963.42 - 1952.87)/5 km² i.e. =211 ha

Productive capacity of 211 ha in Sunderbans may be calculated on the basis of average production of fuel and Timber for Str and 24 Parganas Forest Divisions as follows:

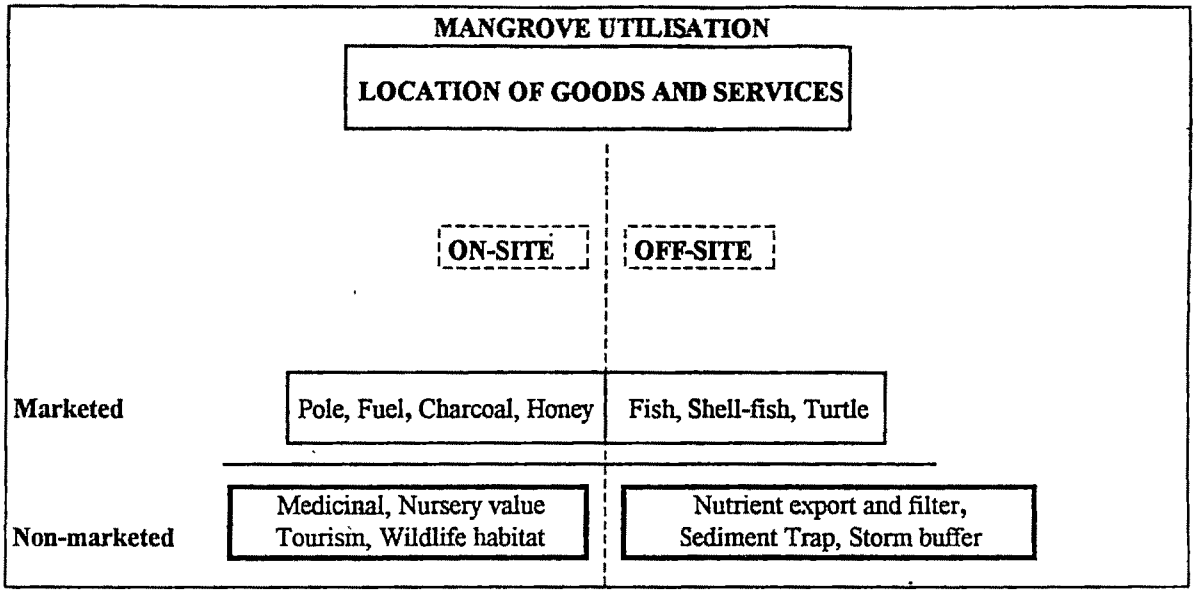
For 22 FPC & EDC of **STR** over 106 ha, the

- production of Timber would be 106 x 3.02 m^3 = 320.12 m^3
- production of Fuel wood would be 106 x 0.63 m^3 = 66.78 m^3

For 21 FPC of **24 Parganas Forest Division** over 105 ha, the

- production of Timber would be 105 x 0.22 m^3 = 23.10 m^3
- production of Fuel wood would be 105 x 0.45 m^3 = 47.25 m^3
- Therefore, the Total production potential = 320.12 + 66.78 + 23.1 + 47.25 = 457.13 m^3 per year from JFM activities over an area of 1000 km² after meeting the smallwood and fuelwood requirements of the members of the protection committee. Thus in effect this regenerated mangrove will produce timber and fuel wood, let alone the offsite and non-marketable values giving rise to their usual a) Off-site, b) On-site c) Marketable and the d) Non-marketable values.

Figure 1: Valuation of Mangrove (Brown, 1997)



Minor Forest Produce: Sunderbans Mangroves produce a number of minor forest produce. The tiger bite in Sunderbans used to be treated with crushed leaves of *Acanthus illicifolia.*

- Bark of *Rhizophora* is used to treat fractures.
- Bark of *Bruguiera* is used to treat minor cuts.
- Juice of *Sonneratia* is used to treat bleeding piles.
- Latex of *Exoecaria agallocha* is used to treat skin rashes.
- *Sonneratia* fruits help digestion.

Apart from medicinal use there are certain traditional uses of intertidal plants of Sunderbans as below:

- *Salicornea brachtiata* on burning produces Soda ash.
- *Aegialities rotundifolia* on burning produces high grade salt.
- Both *Rhizophora* (38%) and *Ceriops* (29%) produce good yield of bark Tannin (Dey, 1957).
- *Nypa* palm leaves for roofing and petiols for alcohol, fruits are edible.
- *Achrosticum aurium* tender leaves are used as vegetables.
- *Sonneratia caseolaris* has beaverage potentiality.

This apart Sunderbans is famous for its production of honey and bees wax.

All the mangrove plants are highly necter bearing. This attracts the rock bees (*Apis dorsata*) to visit Sunderbans during summer months the flowering season. Floweing starts with bloom of *Aegiceros corniculatum* during last week of March and is followed by the flowering of *Acanthus illicifolius*, *Avicennia species*, *Sonneratia apetala*, *Rhizophora* species. This continues for two months during April and May. After that *Excoecaria* flowering starts polluting the honey test. *Aegiceros* and *Acanthus* having highest salt gland concentration (Ball, 1984) produces the most viscous honey of Sunderbans (Sanyal, 1983).

Other permits: Permits for collection of Golpatta (*Nypa* leaves) for the purpose of thaching has been discontinued. Only the permit holders for honey collection and fishing can use the leaves for thatching their boats. But collection of the edible *Nypa fruiticans* fruit is now totally banned, in order to conserve the regeneration of this dwindling species. Permits also used to be given for collection of shells of *Ostrea*, a practice which has ceased at present.

Fisheries Resources: Critical analysis of lower Sunderban delta shows that the resources have high potential for fisheries development (Sharma, 1994). next to agriculture, fisheries provide the main employment in the region. Availability of skilled manpower is conducive to fishing.Nearly 42% population belong to the Scheduled Cast and Tribe, most of whom are engaged in Fishing. An opinion poll on preferred land use was conducted on 108 families, which revealed thet fishery and agriculture sectors have equal weightage and importance (Sharma, 1994).

Hugly-Matla estuary which is the maximum influence zone of Sunderbans, experience lion share of catch from winter bagnet fishery from November to January. Major catch is constituted of Hilsha (*Tenulosa ilisha*) fish catch; the counterpart of Salmon in India. Hilsha has to migrate upstream for long distances The migration has since been disturbed due to construction of Farakka barrage in recent years however, Hilsha catch shows improvement, the shole moves more to Rupnarayan river upto Bandar point, nearly 150 km upstream from mouth of Hugly.

There are 5550 Nos of registered boats to fish within the forest areas of Sunderbans (Annual Report of Forest Directorate, WB, 1990-91). During the year 1990-91, 26378 permits were issued each time carrying 4 persons per permit (average).

"Relationship among primary productivity, plankton and fish production in Sunderban Coast during winter"

Table.1 : Rate of ^{14}C assimilation and energy transformation being controlled by half bound carbondixide and soluble salts at various places of Hooghly - Matlah estuarine system

Stations	Rate of ^{14}C Assimilation ($gC\ m^{-2}day^{-1}$)	Rate of Energy Transformation ($.000\ Cal\ m^{-2}day^{-1}$)	Electrical Conductivity ($mScm^{-1}$)	Total Dissolved Solids ($X\ 10^{-6}gl^{-1}$)
Canning	1 255	12 337	10.391	0 542
Fraserganj	0.568	5.583	13 498	6.810
Bokkhali	0.915	8.994	18.503	8 632
Jamboodwip	2 429	23.877	22.316	10.000

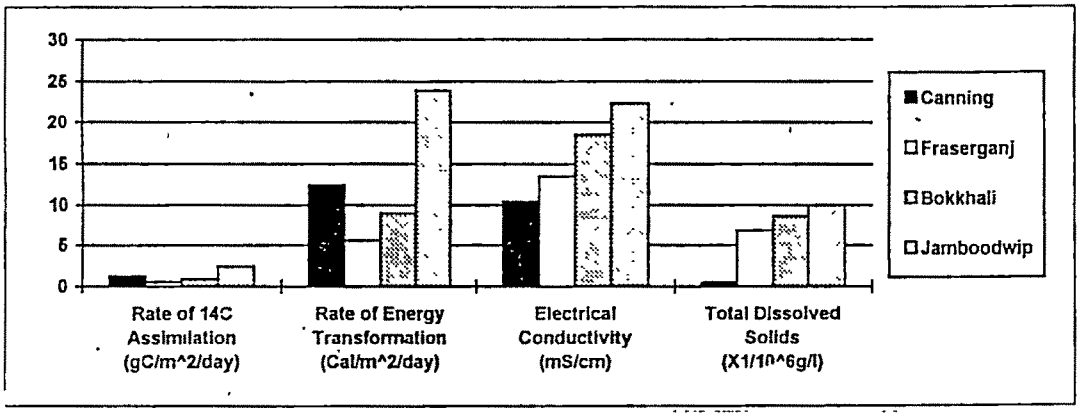
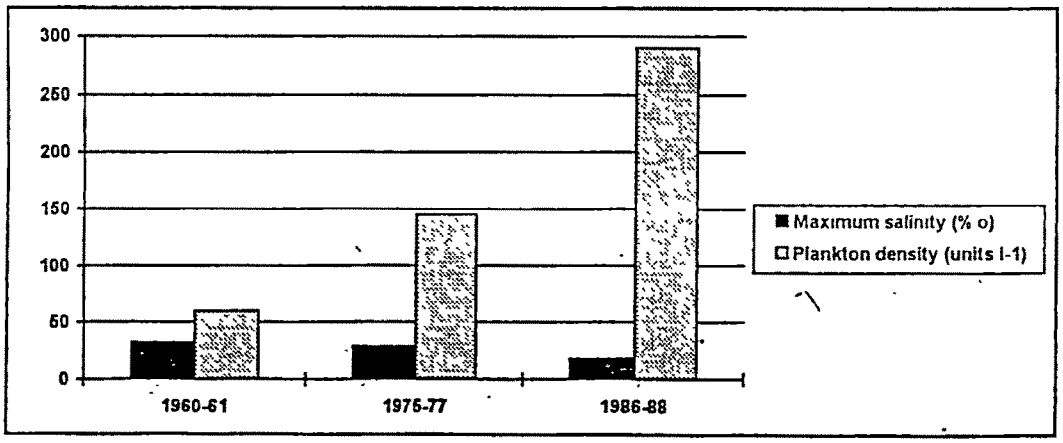


Table 2: Physico-chemical Characteristicsd of Estuarine Waters

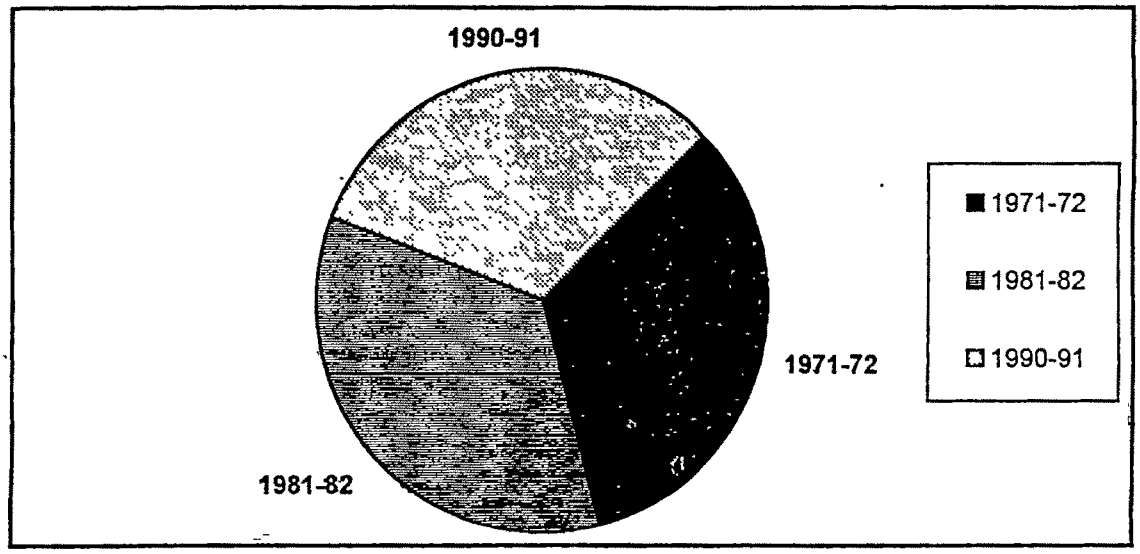
Zone	Pre-Farakka	Post-Farakka	
	1960-61	1975-77	1986-88
Maximum salinity (% o)	32.80	29.240	18.604
Plankton density (units l^{-1})	60.21	144.790	290.230



It is apparent from Table 1, that nearly 21% of estuarine fish catch is Hilsa (*Tilusha*) and 10% are the prawns

Table 3 : The details of catch during last 3 decades for Hilsha (*T.ilisha*) was as below

Year	Catch (in t)
1971-72	6573.3
1981-82	6886.0
1990-91	6256.5



95% of total estuarine catch comes from lower estnarine i.e. between Sunderbans and Digha.

6.2.1 Winter Migratory Bagnet Fishery: Winter migratory bagnet fishery accounts for nearly 80% of total estuarine catch. Since coastal zone extends upto Diamondharbour (CZMP of West Bengal, 1996) the statistics of bagnet fishery with calculations of CPUE has been taken into consideration. Otherwise total catch of estuary takes account upto Nawadwip the tidal limit of Hugly. The main components of the bagnet fishery in order of abundance are *Harpodon nehereus*, *Setipinna spp.*, *Trichiurus spp.*, *Pama pama* and prawns which together forms 64.5% of winter bagnet catch.

6.2.2 Economic utilisation: The Winter Bagnet Fishery is sold both live as well as dried. the Bombay duck constitutes principal dried fish. Jambudwip Island is a major area of drying the fishes. The fish landing places are situated mostly on the western part of Sunderbans at Namkhana, Kakdwip, Raidighi. Canning is a central landing point and Nazat, Basirhat, Hingalgange are the eastern points. The economics of the fish utilisation and price there to as fetched, stands as below (Paul, 1997):

Table 4

Year	Live fish sold (ton)	Live fish dried (ton)	Dry fish produced (ton)	Sale proceeds (Rs million) for the fishes (both dried and live)		
				Live	Dried	Total
1993-94	224.0	17469.0	3540.9	15.9	58.2	74.1
1994-95	436.9	20383.7	4173.0	30.8	65.5	96.3
1995-96	383.2	27802.7	5499.1	20.7	101.4	122.1
1996-97	701.3	35143.3	6939.2	48.6	133.8	182.4

81.9% of the fish catch takes place during November to January and 3.6% the lowest catch during March to June. The catch statistics collected by Central Inland Captured Fisheries Institute, Barrackpur through their regular projects (results published in the Annual Report) stand as below (Mitra, 1997):

Table 5

Year (Feb.-Jan.)	Total Fish Yield (metric ton)	Total Yield (ton) & CPUE of winter migratory bagnet fishery (Nov.-Jan)		Hilsha Drift Gill-net Fishery (ton)	Fishing Effort FE (.000 net-tides)	Ln (CPUE)
		Total	CPUE (Kg.)			
1984-85	26043.2	19639.5	130.4	1977.2	150.61	4.87
1985-86	23941.7	17581.4	151.79	1024.6	115.83	5.02
1986-87	22143.2	8125.8	83.37	1935.0	97.47	4.42
1987-88	31591.8	23775.6	157.47	1177.0	150.98	5.06
1988-89	41522.0	34116.4	157.43	1713.0	216.71	5.06
1989-90	33139.6	25688.8	107.4	1563.7	239.19	4.68
1990-91	41569.4	26669	198.7	6256.5	134.22	5.29
1991-92	37405.2	21460.8	121.2	3568.5	177.07	4.80
1992-93	36900.0	26346.3	124.4	4051.8	211.79	4.82
1993-94	34578.5	17693	78.2	1529.0	226.25	4.36
1994-95	24476.6	20820.4	93.7	904.1	222.20	4.54
1995-96	34280.4	28185.9	89.5	2438.1	314.93	4.49
1996-97	51126.1	35844.7	95.75	7653.4	374.36	4.56

Table 6 : Contribution of dominant fish species and prawns (in t) to the total estuarine fish catch

Name of species	Contribution to the total catch		% in the total catch		Contribution to total catch		% of Col.6	% of Col.7
	Feb.' 89 - Jan.' 90	Feb.' 88 - Jan.' 89	Feb.' 89 - Jan.' 90	Feb.' 88 - Jan.' 89	Feb.' 89 - Jan.' 90	Feb.' 88 - Jan.' 89		
Tenulosa ilisa	1563.4	1720.9	4.7	4.1	1563.4	1720.6	21.0	21.3
Pama pama	3978.2	6641.9	12.0	15.7	374.7	440.1	5.0	5.5
Setipinna spp.	4379.4	6059.6	13.2	14.3	322.9	336.2	4.3	4.2
Trichiurus spp.	3978.6	3792.2	12.0	9.0	189.4	103.8	2.5	1.3
Harpodon nehereus	4735.7	8000.2	14.3	18.9	528.0	462.5	7.1	5.7
Tachydurus jella	432.8	799.3	1.3	1.9	244.0	354.8	3.3	4.4
Stromateus cinereus	160.1	896.9	0.5	2.1	103.4	123.7	1.4	1.5
Polynemus peradiseus	98.2	313.4	0.3	0.7	78.2	66.2	1.0	0.8
Coilia spp.	537 2	1347.5	1.6	3.2	302.6	528.6	4.1	6.6
Ilisha elonhata	413.4	501.8	1.2	1.2	101.2	98.7	1.4	1.2
Sciaena biauritus	87.5	362.1	0.3	0.9	60.3	67.3	0.8	0.8
Polynemus indicus	191.3	177.4	0.6	0.4	191.3	177.4	2.6	2.2
Chirocentrus dorat	98.1	90.6	0,3	0.2	82.6	90.6	1.1	1.1
Prawns	2670.0	3451.9	8,1	8.2	760:8	1004.7	10.2	12.5
Others	9815.7	8164.9	29,6	19.2	2548.0	2492.4	34.2	30.9
Total	33139.6	42320.6	100,0	100.0	7450.8	8067.6	100.0	100.0

Calculation of Maximum Sustainable Yield (MSY) and Optimum Fishing Efforts (f_{opt}): For fishing to be sustainable the fish yield should equal to net growth in biomass. Decrease in biomass of the fish stock due to fishing must be in equilibrium with the net increase in biomass resulting from (i) growth, (ii) recruitment; minus losses due to natural mortality.

Based on assumption of logistic growth of the fishing stock in equilibrium or steady state of fishing, the equilibrium yield YE and equilibrium biomass BE will have relation:

$YE = k\ BE - (BE)^2/B$ (where k is instantaneous rate of increase in biomass, B(=biomass of unfinished stock {equivalent to virgin biomass}).

Assuming that:

- The growth of fish population in Hugly-Matla estuary can be represented by a logistic equation.
- Fishing has been in equilibrium.
- Population dynamics of stock can be studied in isolation from other species in the environment (Troadec, 1983).

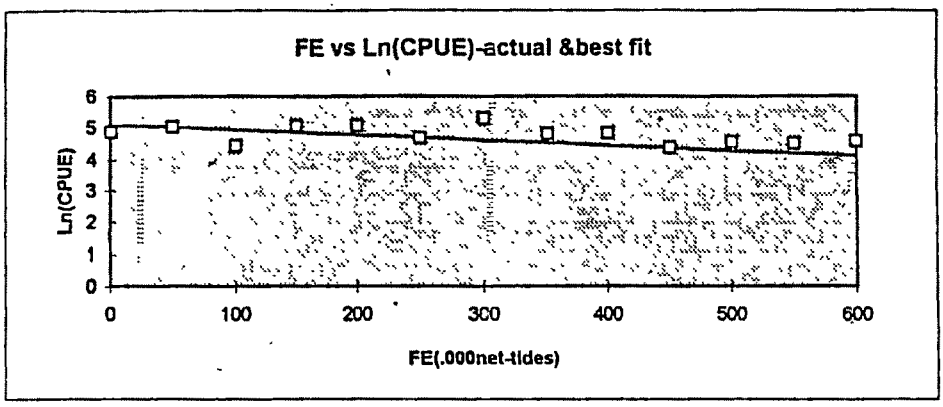
Fox model can be applied as (Beddington, 1983):

Ln (UE) = a - bFE where UE is the Catch Per Unit Effort (CPUE), and FE is Fishing Effort, **a** being the 'Intercept' and **b** the 'slope' of the straight line. Applying this equation

- **Maximum Sustainable Yield, MSY** = $(1/b)\ (e^{(a-1)})$
- **Optimum Fishing Effort,** $f_{opt} = 1/b$

The optimum stocksize Bopt = B /e = 0.368 B (which is more conservative than 'Schaefer model' where, Bopt is 50% B).

'Fig. 2

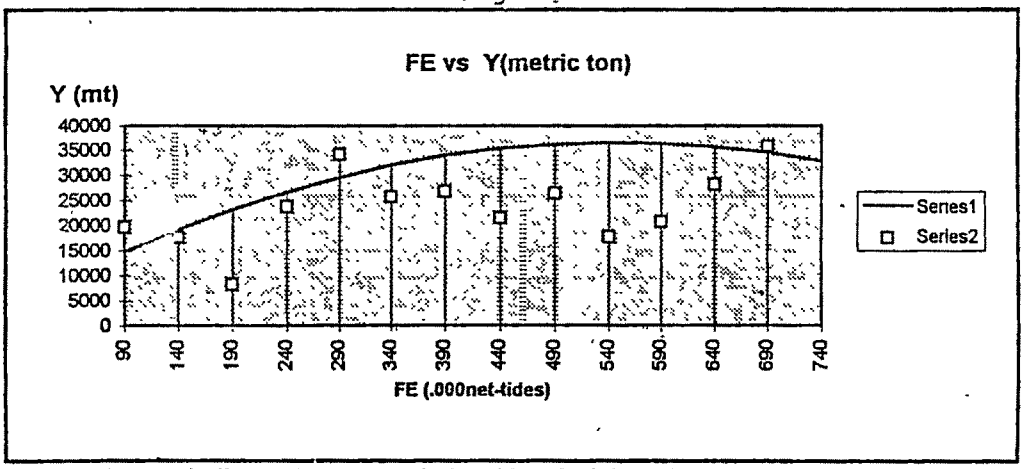


The values of CPUE and Fishing Effort (FE) was collected for the yield of Winter Migratory Bagnet Fishery, which is little less than total yield. Therefore, calculating on the basis of bagnet yield will be a rather conservative approach. Thus regressing the Ln (CPUE) on FE from the Table

Intercept = a = 5.100463
Slope = b= -0.00165 (ref. Graph 2)
MSY = 36586.82 Metric Ton
f_{opt} = 606 Thousand Net - Tides

Plotting the fish catch (Y) against Fishing Effort (FE) as in Graph 3.

Fig. 3



The parabolic (2nd degree) relationship of Yield and effort stands as below:

$Y = 5411.27 + 113.2705x - 0.1029936x^2$ (Sum Sq. Diff. = 3.151469E+08)
Where y = Yield
x = FE (Fishing Effort)
MSY = 36600 ton.

f_{opt} = 590 Thousand Net - Tides

Therefore, it is apparent from both the methods of calculations that, average catch rate (Total Catch) is well below MSY (36600 / 0.8) = 45,750 t). Following steps may be taken to ensure sustainable use of the coastal fisheries resources of Hugly-Matla estuary:

1. Trawlers should maintain logbooks and landing assessment should cross-check, so that MSY (36600 metric ton) is not exceeded at any time for Winter Bagnet Fishery.
2. Close period should be declared from 1st November to 1st February for the Hilsha and major juveniles. The late monsoon is the breeding period for many estuarine fishes. Minimum mesh size limit is to be fixed at 15 cm x15 cm which is the age old standing order of the Sunderbans Forest Dept
3. Fishing efforts should vie around 600 Thousand Net-tides (Winter Bagnet Fishery) to harvest best sustainable catch. It should be preferably kept below this limit.

Coastal Aquaculture: Aquaculture didnot exist in W. Bengal 10-12 years ago. West Bengal is endowed with the largest brackish water resource of the country specially the Sunderbans. Owing to high tidal amplitude and abundance of lowlying areas, with ground salinity having less agricultural value (Ghosh, 1996). Average monsoon paddy yield in Sunderbans is only 2.5 tons/ha/y as against the national average of 3.5 t/h/y. Productivity of Pulse, oil-seeds (mustard, sunflower) are 50% less of national figuer of 659 kg and 407 kg/h/y respectively (Sharma, 1994).

Aquaculture land along Bengal coast is available over 405, 000 ha out of which 33000 ha have been utilised so far (Sanbhogue, 1995). As per cartographic statement (Annexure VIII) the aquaculture area within CRZ of WB is only 26, 718 ha and Ponds and Lakes 441 ha. Traditional method of brackish water culuture is most common in Sundebans. The practice is to raise peripheral dyke around a big area of low lying land sometimes measuring upto 100-150 ha for impoundment of water. Brackish water is allowed to enter through sluice gates.

In West Bengal so far there are 200 Nos. of semi-intensive and intensive Aquaculture farms distributed in the districts are as below (MPEDA, 1996):

- Midnapore district: Total 120 Nos. (12 Nos. semi-intensive, 108 Nos. modified intensive).
- 24 Parganas (South) district: Total 68 Nos. (11 Nos. semi intensive, 57 Nos. modified intensive)
- 24 Parganas (North) district: Total 12 Nos. (5 Nos. semi intensive, 7 Nos. modified intensive).

As on 1995 the present utilisation has since increased over 1, 50, 000 ha. area.

West Bengal Fisheries Department issues license under Essential Commodities Act 1955. Total 621 licenses were issued to producers, 284 licenses to whole salers and commission agents and 75 to seafood exporters (Sharma, 1994). Predatory fishes are often cultured along with prawn which reduces production. Average production of 'extensive acquaculture system' is 300-400 kg/h/y.

Presently some multinational business house like Hindustan Levers, Sunderban aquatic, Agronet H&G. India started "modified extensive" culture to achieve 4-5 t/h/4 month production (Ghosh, 1996). 43% of state's mechanised boat i.e. 1600 boats we licensed in Sunderbans (Sharma, 1994 p-81).

Usually available species raised from such a system of BW Acquaculture are: *Liza parsia, L.tade, Lates calcarifer, Mystus gulio, Penaeus indicus, Metapenaeus monoceros, M.brevicornis, Leander styliferus.* They require longer duration to grow marketable. In small part of Sunderbans within Sandeshkhali I & II blocks which is within Calcutta sewage influence zone Paddy cum fishery is practiced. At moderate salinity, the yield in paddy-cum-fishery vary from 749 to 878 kg/h with 8-28.6% prawn (Ghosh, 1994).

Although the prawn seed collection in Sunderbans has been recorded by IUCN to be around 540 million per year (Choudhury & Choudhury, 1981) but a recent survey

Sustainability Problem: The tiger prawn post larvae collection is causing harm to the fish and shell fish diversity as such. Let alone the reduction of percapita minimum catch of 70 nos. in 1991 to 27 nos. in 1995 (discussed in para 5.2). recently Supreme Court of India has directed to carry out only 'traditional' and 'modified traditional' methods of Coastal aquaculture. There should have been a huge demand-shortage for the tiger prawn PL after this. But that was not the case in Sunderbans. Reason can be adduced to the large scale illegal trafficking of PL to Bangladesh. Supreme court also directed to form both Central Coastal Aquaculture as well as State Coastal Aquaculture Boards. This Board will determine the Coastal Aquauculture issues case by case in order to run the show **sustainably.**

Average No. destroyed for each P.monodon PL: 318 (other prawn), 8 (Fish), 60 (Crab), 1 (mollusc), 13 (Unidentified). i.e. total 400 nos.

The figures of seeds destroyed per shrimp seed collector was lalso determined to be as below:

Average: In order to catch 8106 No.s of shrimp seeds each collector destroyed 1304937 other prawn, 60581 Fish, 246097 Crab, 8391 Mollusc, 66792 Unidentified meroplankton. i.e. total of 1686801 Nos. other meroplanktons

Oyster Culture: In Sunderbans there are two species of edible oysters namely, *Cassautrea cuculata* and the clam *Anadara granosa.* Normally the upstream side of cemented jetties of Sunderban are always clothed width shells of *Cassautrea.* In some areas within Basanti Police Station local people have the knowledge about edible character and often the raw carnel is eaten. However, inspite of abundance of available spats in the creeck waters systematic farming is yet to be taken up.

Usually oysters grow well on a hard rocky bottom or on underwater structures which are left exposed at low tides. In South-India already oyster farming technology has become popular with "rack technique" and "tray culture" particularly in Tuticorine bay. *Phoenix* stumps coated with cement can be used as substrate for spat collection, which can be reared through tray culture. Clusters of oyster cells also surve as preferred substrate. The boxtype cages with transplanted spates are allowed to grow for further two months. Periodic checking during this period is necessary to avoid predation if any. In the meantime seed oysters grow to an average of 50 mm. Size. The oysters from the box-type cages are transferred to the rectangular trays of 90*60*15 cm. each tray holding 150 to 200 oysters. Twenty such trays could be placed on a single rack of 14*2 m. size. Periodical cleaning and supervision is necessary to remove the predators and clogging of cage by the seaweeds if any. The oysters reared in Tuticorin attain a marketable size of 80 to 90 mm. weighing about 80 to 100 g. with meat forming 8 to 10 per cent (Nayar and Mahadevan, 1983). The oysters in Pulicat attain mean and maximum sizes of 92.1 mm. and 113 mm. respectively at the end of one year.

Oysters attain marketable size within a year. Maximum meat content would be obtain only when the oysters are sexually ripe attaining 80 to 100 mm. size. Soon after spawning the oyster meat will loose the test. The oysters are shucked by placing the depurated oysters in hot water for 2 minutes. The meat is thoroughly washed and then used for consumption. It is high time that large scale farming of *Cassautrea* be started in Sunderban creeks where water column in rich in spats.

Edible Algae Culture: The hitherto unexplored coastal resources in W. Bengal are a) Edible algae culture and b) Oyster culture. The feasibility of different items have already been started as trials at places. Edible algae culture for food as well as for the extraction of Agar is common place in South India.

The future of edible algae culture is bright in Bengal. During the years there had been considerable production of edible algae in Japan and other South east Asian countries, as part of their aquaculture practice. Recently edible algae culture has gained ground in South India with the Agar yielding *Gracilaria* species. The coastal Bengal has a good population of *Enteromorpha intestinalis*, a species of excellent promise as an edible algae. *Gracilaria* is also available in Sunderbans coast. Agar cakes are delicious tifin food, rich in protein for human consumption. The rate of natural production of *Gracilaria* is around 20 g./m2/week in South India. Similar rate of production may be predicted for the species *Enteromorpha.*

Tourism Resource In Sunderbans: Sunderbans harbour tourists from both domestic and outside interests. The difficult approach and internal communication, the fear of man-eating tigers, the larking Crocodile and sharks of the rivers attract adventure tourists. Long water cruise also adds to the attraction. Principal transport system in Sunderbans is the waterways. In addition to the motor launch services from Caning, Sajnekhali, Namkhana, Nazat, Hasnabad, Raidighi and Dhamakhali, most of the inland traffic is carried by country boats with sails. Country boats are often fitted with inboard motors to avoid skull works. The donga or dug-out, is used on smaller streams and swamps (Dey, 1987).

Other facilities for tourists: Tourism Department of West Bengal has arranged conducted tourism trips from Calcutta via Sonakhali. From Sonakhali the tourist launches Madhukar or Chitralekha (48 seater) launch take the tourists to Tiger reserve areas. A great number of tourists reserve launches from Caning to visit Sunderbans Tiger Reserve, Kalas beach, Lothian Island Sanctuary and Bhagabatpur Crocodile farm.

Tourists from Calcutta can come to Sonakhali or Namkhana by express buses. Then local trips to Sajnakhali, Netidhopani from Sonakhali or Bhagabatpur Crocodile farm and Lothian Island sanctuary from Namkhana can be cruised by motorised country boats. Trained tourist guide service is available from Sajnekhali Tourist lodge. Arrangement of light and fan exist here with Solar Panels. Small motorised boats are available on hire at Sajnekhali jetty. Pakhirala lodge can be reached by van-rickshaw from Gosaba within 2 hrs.

Watch Towers with fresh water pond exist at following places for facility of wide life viewing:

1. Sudhanyakhali
2. Sajnakhali
3. Netidhopani
4. Jhingekhali
5. Burirdabri
6. Gabbani
7. Bakkhali
8. Dhanchi
9. Lothian Island

There is another watch tower at Haldi which is core area of Tiger Reserve and is kept, out of bounds for tourists.

Tourist flow: The Sunderbans tourists consist of both Indigenous and Foreign Tourism in **Sunderbans Tiger Reserve** as below:

Table 7: Tourist flow Sunderbans Tiger Reserve

Year/No. of Tourists	Indian		Foreigner	Total
	General	Student		
1994-95	18719	765	214	19698
1995-96	23554	518	308	24380
1996-97	29022	886	385	30293
1997-98	30171	147	178	30439

Tourist figures for 24 Parganas Forest Division stands as follows:

Table 8: Tourist flow 24 Parganas Forest Division

Year	No. of Tourists	No. of water crafts allowed	No. of cameras allowed	Amount realised (Rs.)
1994-95	1126	40	26	5109
1995-96	1467	51	42	7273
1996-97	2252	75	48	18301
1997-98	3083	102	89	14957

Non-Forest Tourism: In Sunderbans the Sagar Pilgrimage attracts maximum tourists (nearly 100,000 Nos.). This is considered as once in a lifetime one, for the pilgrims.

There are other places of attractions like the Jatar Deul Temple near Raidighi. This temple is 1100 year old and is an archaeological preserve.

The Khana-Mihirer Dhibi at Berachampa and Chandraketugarh thereby remains attraction for Calcutta tourists. These are archaeological preserves of Gupta era (7th century). The access to foreign or high budget tourists to Sunderbans can be improved by scope for development of future tourism in Sunderbans:

a) Using the Gosabà helipad where visitors from Dum Dum Airport can land within 15 minutes.

b) A catameran service from Calcutta to Namkhana.

c) A proposal for developing a tiger rescue centre in Danchi Island is on. Facilities of 3 watch towers in this tiny island can serve for tiger sitting by the tourists. There is a good growth of mangrove forests, full of axis deer and wild boar in Danchi island. A tentative site has also been selected across the creek opposite Danchi island within 'G' Plot. The catamaran carried tourists can start from Calcutta half here. Then they can make to and through journeys to Tiger Project and Kalas beach in one day.

d) Proposal for further development of tourism.

Selected References

Beadington, J.R. and Retting R.B. (1983). Approaches to the regulation of fishing effort, FAO Fisheries Technical Paper (243) : i-v, 1-40.

Brown, B.E. (1997). Integrated Coastal Management : South Asia Department of Marine Sciences and Coastal Management, University of Newcastle, Newscatle upon Tyne, United Kingdom. p.1.5.

Mitra, P.M. and Karmakar, H.C. (1997). Fisheries of Hooghly - Matla estuarine system - An appraisal. Bull. **67** : 8.

Royce, W.F. (1987). Fishery Development. Academic Press, London. 248 pp.

Paul, S. *et al.* (1997). Winter Migratory Bagnet Fishery of the Hooghly Estuary - An economic Evaluation. Bull **76**. Nov : 1-16.

Sanyal, P. (1998). Sustainable Fishery in hugly-Matla Estuary, jour banabithi, Environment Department, Govt. of W. Bengal, India, June : 25-28.

Troadec, J.P. (1983). Introduction to Fisheries Management : advantages, difficulties and mechanisms. FAO Fisheries Technical Paper (224) : i-v, 1-58.

Annual Reports of Central Inland Captured Fisheries Institute (1984-1996).

□

MOLECULAR PHYLOGENIES & EVOLUTION

R.K. Poddar
Former Vice-Chancellor
University of Calcutta, Calcutta

Until recently, comparative studies of closely related organisms in various geological periods as revealed in their fossil records provided major methodological tools for investigations into the process of biological evolution. Although the overwhelming similarities of underlying biochemical and biophysical processes point towards a common ancestry of all present-day living orgnisms, classical methods of study of biological evolution do not provide data leading to any plausible explanation as to how this might have actually happened. Recent advances in molecular biology enabling as to compare the nucleotide sequences of DNA and RNA and the amino acid sequences of proteins have led to the development of a powerful methodology to investigate phylogenetic evolution at the molecular level since the origin of life. One of the most surprising results of such comparative studies on ribosomal RNA is the emergence of the "Three-Domain" model — the Eucarya, the Bacteria and the Archea — of biological evolution, as proposed by Carl Woese. Another notable contribution of such studies is the conclusive evidence of endosymbiotic origins of mitochondria and chloroplasts. Using concepts such as, "molecular clocks" and "evolutionary distances" phylogenetic "trees" of evolving genes and proteins of widely diverse species can now be constructed with the help of various computer programs.

Selected References

Strickberger, M.W. (1995). *Evolution* (2nd Ed.). Jones and Barlett Publisher Inc., USA.
Li, W-H, and Graur, D. (1991). *Fundamentals of Molecular Evolution.*

□

RODENT MENACE IN THE GANGETIC PLANE, SOME ASPECTS OF THE REPRODUCTIVE PHYSIOLOGY OF WILD INDIAN HOUSE RAT (*Rattus rattus*) AND THE APPLICATION OF SOME CHEMOSTERILANTS IN THE CONTROL OF FERTILITY

C. K. Manna

Endocrinology Laboratory, Department of Zoology,
University of Kalyani, Kalyani-741 235, Nadia, W.B.

Rodents constitute the largest order of existing mammals. Not only in the multiplicity of taxa but also in the enormous swarms of individuals, this group stands out among all mammals. As may be expected in a country like India which exhibits diverse ecological conditions, the rodent fauna is also varied. The rodent fauna of West Bengal may not be the exception. Practically speaking Bengal includes terai of the Duars, the northern para delta of the Ganga - Brahmaputra doab and the Barind, the eastern margins of the Surma Valley and the plains along the R. Megna and Chittagong Coast, the western margin of lateratic piedmont pains between the R. Hooghly and the Peninsular Block and the coastal plain and the Delta of R. Ganga proper between R. Hooghly-Bhagirathi Padma - Meghna and the sea. The deltaic plain of Bengal is of multiple origin, so that strictly speaking, we have been here more than one delta. Although thorough studies have not yet been properly made but it is assumed the rodent fauna is also varied in these regions.

Present survey work was conducted on both sides of the River Ganga and especially in the District Nadia and North 24-Parganas on the eastern side and in the District Burdwan and Hooghly on the Western side. The survey work clearly points out that approximately 98% of the people are affected by various types of rodents especially in the villages. The extent of damages are being estimated. The survey work also points out that the preponderent species is the wild Indian house rat (*Rattus rattus*).

A careful perusal of the literature on reproduction in one wild murid i.e. *Rattus rattus* from various parts of India is reported to have seasonal fluctuations in the breeding pattern (Harrison, 1951; Southwick, 1966 ; Barnett and Prakash, 1975). This study is aimed at not only describing their breeding pattern of the adult, but also some of the histophysiological aspects of the testicular development in the developing rats that were born in the captivity from females mated in the nature itself. Also a thorough knowledge of the germ cell types and spermiogenesis have been made for better understanding of the cycle of seminiferous epithelium. This study has been followed after Leblond and Clermont (1952).

It has also been reported that *Rattus* sp. is a prolific breeder and they are the carrier of

various types of dreaded diseases. Considering the severity of the problem the controlling meas ures should be followed using the Integrated Pest Management Programme. It is assumed that chemosterilants should be used as one of the integral componets in the integrated pest management programme. Considering this idea, administration of simple esters of methane and ethane sulphonic acids produces antifertility patterns in the male rodent (Jackson *et al.*, 1961). Since the time of Jackson, numerous investigators have tried to investigate the effectiveness of these esters in controlling the fertility of the rodents and birds (Saha and Ghosh, 1982; Nandy, 1993; Aich, 1995).

Using Busulphan, one of the most potent sulphonic esters, on Rattus sp., it was observed that it possess all the characteristic features of the active chemosterilant. Due to its action there is no change in the body weight, accessory sex gland wt. and libido. Testicular wt. and seminiferous tubular diameter decreased. It had an inhibitory effect on the accessory sex glands also. It caused some reduction of the steroid enzyme activity within the testis and accessory glands. The changes which were noticed in the Rattus sp. may be due to direct action of this sulphonic ester. Not only busulphan, there are other groups of sulphonic esters or chemosterilants too which can be used for the control of fertility. But before using these there should be thorough study using laboratory animals.

Selected References

Aich, S. (1995). Histophysiological study of the male reproductive organs of a rodent pest (*Rattus rattus*) in West Bengal : A critical evaluation of the control of fertility. Ph.D. Thesis., University of Kalyani.

Barnett, S. A. and Prakash, I. (1975). Rodents of Economic Importance in India. Arnold Heinemann, New Delhi.

Chopra, G., Kaur, P. and Guraya, S. S. (1996) Rodents: Ecology, Biology and Contrc' R.Chand & Co., New Delhi-2.

Harrison, J.L. (1951). Reproduction in rats of the subgenus, *Rattus*. Proc.zool.Soc.,London. **121** : 676-694.

Jackson, H., Fox, B.W. and Craig, A.W. (1961). Antifertility substances and their assessment in the male rodent. J. Reprod. Fertil., **2** : 447-465.

Leblond, C.P. and Clermont, Y. (1952). Definition of the stages of the cycle of the seminiferous epithelium in rat. Inn. N.Y. Acad. Sci., **55** : 548-573.

Leblond, C.P. and Clermont, Y. (1952). Spermiogenesis of rat, mouse, hamster and guineapig as revealed by the "periodic acid fuchsin sulphurous acid" technique. Ann. J. Anat. **90** : 167-215.

Nandy, P.K. (1993). Histophysiological study of male reproductive organs of two common Indian pest birds with special reference to their control of fertility. Ph.D. Thesis. University of Kalyani.

Prakash, I. and Ghosh, P.K. (1992). Rodents in Indian Agriculture. Vol.1., Scientific Publishers, Jodhpur.

Saha, S and Ghosh, A. (1982). Effect of Busulphan on the testis of a Finch, *Lonchura malabarica*. Arch. Biol. (bruxelles)., **93** : 343-352.

Southwick, C.H. (1966). Reproduction, mortality and growth of murid rodent populations In : K.L. Harris (ed.). Indian Rodent Symposium, New Delhi . USAID.

□

TAXONOMY : ITS CLASSICAL PERSPECTIVES

G. Majumdar

Department of Zoology, University of Burdwan

Burdwan 713104, West Bengal

Systematics	:	Systematics is the scientific study of the kinds and diversity of organism and of any and all relationships among them (Simpson, 1961).
Taxonom	:	Taxonomy is the theory and practice of classifying organisms including formulating its bases, principles, procedures and rules (Mayr, 1966).
Zoological Classification	:	It is the ordering of animals into groups or sets on the basis of their relationships (Simpson, 1961).
Zoological Nomenclature	:	It is the application of distinctive names or vocabulary to each of the groups recognised in the zoological Classification (Mayr, 1976).

There are three levels of Taxonomy loosely corresponding with three period of Taxonomy :

Levels of Taxnomy :

Alpha Taxonomy	:	Level by which species are characterised and named.
Beta Taxonomy	:	Arranging of spices in their natural system of categories.
Gamma Taxonomy	:	Analysis of intraspecific variations and evoluationary sequence.

Periods of Taxonomy :

First period	:	Study of local fauna
Second period	:	Acceptance of evolution
Third period	:	Study of population

Species Concept

Plato and his followers used the term "eidos' in much the same sense as the species. The species concept of Biologist goes back to John Ray (1866) who in his Historia-Plantanum(1866) used the term Species much as it was used later by Linnaeus and 19th century taxonomist

Defination of Species :

From Genetical point of view :

Spices are actually potential interbreeding population which are reproductively isolated from other such groups (Mayr, 1953).

From evolutionary point of View :

An evolutionary species is a lineage evolving separately from others and with its own evolutionary role and tendencies (Simpson, 1965).

Descrimination Grid :

	Not Reproductively Isolated	Reproductively Isolated
Morphologically identical :		
a) Sympatric	1 Same population	3. Sibling species
b) Allopatric	2. Same sub-species	6. Sibling species
Morphologically different :		
a) Sympatric	3. Individual variant of same population	7. Different species
b) Allopatric	4. Different sub-species	8. Different species

Kind of Type Specimens : (after Frizzell, 1933; and Fernald, 1939)

(I) **Primary types** : The original specimens of any described or figured new species.

(a) Holotype
(b) Allotype
(c) Paratype
(d) Syntype. (=Co-type)
(e) Lectotype

(II) **Supplementary Types** : The described or figured specimens used by any authors to supplement or correct knowledg of the previously defiend species.

(a) Neo-type
(b) Plesiotype

(III) **Typical Specimen** : The specimens that have not been used in published description and papers but which consist of materials which authors have worked on or such as collected at the original locality.

(a) Topotype
(b) Metatype
(c) Homotype

Princeple of priority :

Of all the Zoological Nomenclature, the most difficult to formulate was the onedeterminingwhich of the two or more competing name should be choosen. Arbitariness in nomenclature characterised the period from 1780-1850. Owing to french revolution and Napolinic wars, this was also period of disturbed communication and Taxonomistsof one country were often unware of the new taxa described by Taxonomists in other countries. As such, a large number of synonyms are apparent these days. Father of modern nomenclature from Fabricius, Rudolphi, and Strickland on thought that continuouschange of name could be prevnted if priority was adopted as a basic principle of nomenclature.

Resons for name changes :

I. Changes dictated by scintific progress :

(a) Change the generic component of binomial
(b) Change of specific name
(c) Synonymising of currently accepted species names
(d) Analysis of species complex

II. **Changes dictated by rules of nomenclature** :

(a) Discovery of an earlier Synonym

(b) Discovery of an earlier Homonym

(c) Discovery of an earlier genotype fixation

(d) Discovery of inapplicable type-specimen

The Law of Priority :

The law of priority covers the period from 1st January, 1758 to the present. Its basis can be found in Article 25 of the rules and as amended at Paris (1948), its essential provisions are that; The valid name of the genus or species can only be that name under which it was designated on the

1) That the specific name is accompanied by an indication or in descriptional figures.
2) That the author has applied the principles of binomial nomenclature.
3) That no genertic name or specific name shall be valid unless it is published either-
   (a) with a statement of character of the genus, species, subspecies.
   (b) in case of a name proposed as a substitute for a name which is invalid by reason of being a homonym, with a referance to the name which is there by replaced.
   (c) in case of the generic name or subgeneric name, it should accompany the genotype/ subgeneric fixation.
4) Inspite of fulfilment of the requirements the name will be rejected if it becomes homonymous

Selected References :

Mayr, E. 1966. The proper spelling of Taxonomy. Syst. Zool. **15** : 88.

Mayr, E. 1976. Principles of Systematic Zoology. Tata McGraw Hill Co., New Delhi.

Mayr, E., Linslay, E.G. and Usinger, R.L. 1953. Methods and Principles of Systematic Zoology McGraw Hill. New York.

Simpson, G.G. 1961. Principles of Animal Taxonomy. Columbia Univ. Press, N.Y.

□

ROLE OF SOIL FAUNA IN INCREASING FERTILITY AND PRODUCTIVITY OF SOIL

Subrata Roy

Zoology Department, Burdwan University

Burdwan-713 104, W.B.

The soil is known to be the abode of a very diverse range of living organisms including fungi, bacteria, varieties of invertebrates and burrowing vertibrates. The food resource that support these organisms is the dead plant material (plant litter)shed by vegetation. The soil organisms utilize this food source by the process of decomposition. Many of the mineral element on which plants depend for growth can only be taken up when they in inorganic form (e.g.N_2 as NH_4 or NO_3).

It is during the decomposition of the plant litter by soil organisms that the organic N is converted to inorganic N, thus replenishing the supply in the soil. The same argument may apply to other elements such as P and S.

The invertebrate community found in soil is a very diverse one with practically every major group of terristrial invertibrate, represented, ranging in size from protozoa to earthworms.

Termites, millipedes, and earthworm feed directly on plant litter. other including some protozoa and nematodes, feed on bacteria. Many groups perticularly some taxa of Collembola and mites feed on fungi.

Animal activity is unusually delayed until some microbial decomposition has taken place. The initial effect of the animal feeding is thus to bring about further decomposition. The secondary effects of animal action are, however, probably more significant to the overall process. First among these ise the breaking open of plant and microbial cells, which results in the release of the mineral elements; Second, the animal activity stimulates secondary waves of microbial action by breaking up the litter into smaller particles increasing the surface areas for microbial colonisation and exposing new surface for enzymatic action.

Soil fertility may be considered to be the ability of the soil to satisfy plant demands for nutrients, water and an adaquate aerated physical matrix for the growth of roots. It is after thought that biological aspects of soil fertility are solely concerned with nutrient supply but this is not so. The activity of a wide range of organisms affects physical properties of the soil they inhabit.

Soil scientists are of opinion that the original size and composition of the soil particles is generally determind by the parent materials while the degree of aggregation and spatial distribution (both vartical and horizontal) and different size fraction is strongly influenced by soil organisms such as earthworm and termites. In particular the amount, type and distribution of clay fraction of the soil may be perticularly influenced by transport activites of the termites. This is of course importent in determining nutrient availability through exchange phenomena The proportion of different clay minarals can also be modified by organic complexing as a result of Biological activity.

For a particular rainfall patern the soil water regime is determined by the infiltration rate, water holding capacity of the soil, soil water conductance, and soil depth. All of these factors are influenced by the organic status of the soil and hance by activities of soil organisms. The rate of decomposition determine the extent of the litter, layers on the soil surface, which influences the rate of infiltration. Soil organic matter levels in soil contributes to the misture holding capacity, while the burrowing activities of soil animals influence the permeability.

It has been postulated that nutrient cycling is stabilized in part because of the diversity of soil organisms and their functional inter-relationship. The role played by different component of soil fauna in enhancing the fertility and productivity of soil may be summerised as follows :

1. **Role of Protozoa** : The protozoans are predominantly bacterial feeders and are most abundant in those litters and soils containing the largest numbers of bacteria and fungi. Soil microcosm experiment have shown that protozoan grazing on the bacteria enhances mineralization of nutrients and makes them more available to plants. Protozoans appear to perform three major function in litters and soils-

i) Increase minaralization of nutrients through bacterial predation, ii) transO .form bacteria protoplasm into higher trophic levels, and iii) help in the formation of the soil aggregates by releasing slimy secretions which acts as cementing substence.

2. **Role of Nematodes** : Nematodes in various ecosystem assist in litter decomposition by dispersing the soil microogranisms atteched on their body surface by ingesting the viable spores and other propagules and spreading them to different sites in viable forms and by helping in building up of microbial population on their excretory wastes and faces. Experimental evidence suggest that nematode grazed bacteria mineralize a substantially higher amount of N_2 from native source than ungrazed bacteria. Similarly a significant correlation have been found between total namatodes and readily available phosphorus for plant growth.

3. **Role of Earthworms** : Earthworms present in soil are considered to be the most beneficial organisms to agriculture and are called "Nature's ploughman". Their burrowing habit enhances aeration as well as easy movement of water through soil. Their casts are rich in mineral contents and are in more easily available form than ordinary soil. The burrowing as well as the casting activity of the worms may favour the development of soil aggregates and there by a condition conductive for plant growth.

4. **Role of Arthropods** : The arthropodan fauna in soil in most cases are very rich in s p e - cies composition and they are known to play significant role in organic decom position and subsequent release of nutrients. Decomposition though initiated by microfloral component cannot proceed indefinitely unless it is being participated by saprophagous forms like insect larvae, millipedes, isopods, collembolans, mites etc These animal accelerate the fragmention and mixing of

litter before it is being acted upon by microflora. The non-burrowing arthropodan mesofauna often aid drainage and aeration by eating out decayed roots leaving channels containing organically rich fecal matter. Termites and ants are very important in the translocation of large quantifies of soil from one place to other. The influence of termites on soil fertility has often been stated to be comparable to that of earthworms. Like earthworm casts the mound soils of termites are known to be rich in nutrients. In semidesert areas where soil structure is inherently poor, the surface openings and galleries of termites may allow moisture to penetrate deep into the soil after rain and subterranean activities of these insects may facilitate aeration. It has been suggested by some observers that soil arthropods especially insects, because of their short life history and consequent ability to react rapidly to environmental changes, can eventually be used to forecast the changes which could take place.

5. **Role of Molluscans** : Although the direct role of molluscs in the decomposition of litter is not very apparent; their indirect role is important in the early stages of breaking and altering the litter both physically and chemically. This activity promotes fungal and microbial growth. The fragmentation increase the large intake, low assimilation and consequent high faecal production of the macrophagous molluscs play a major role in this respect. The expelled food particles which are mucous-coated serve as a attractive foods for macro-organisms, mites, millipedes, and other fauna. In a chain the decoposition process accelerates, inorganic chemicals such as PO_4, N_2 and Ca are deposited in the soil bringing about decomposition.

Considering the multifaceted importance, the soil fauna studies have achieved an international approach and have been recognized as an important part of International Biological Program (IBP) which is mainly concerned "the biological bases of productivity aiming at human welfare". Soil fauna studies are included in the IBP under the title of "Production of soil communities". It has been established that soil fauna through their role on the development of soil structure and profile, through their participation in organic matter decomposition and mineralization processes and also by facilitating easy movement of air and water may help to enhance the fertility and productivity of soil.

Selected References :

1. Wallwork, J.A. (1970) Ecology of soil Animark. McGraw Hill, London.
2. Wallwork, J.A. (1976) The distribution and diversity of soil fauna, Academic Press, London.
3. Lee, K.E. (1983) Earthworms, their ecology and relationships with soils and land use. Academic Press, London.
4. Veeresh, G.K. and Rajagopal, D. (1995) Applied Soil Biology and Ecology, Oxford and IBH Publ. Co. Pvt. Ltd.
5. Reddy, M.V. (1995) Soil organisms and litter decomposition in the tropic. Oxford and IBH Publ. Co. Pvt. Ltd.

□

BIOMONITORING OF AQUATIC POLLUTION- CONCEPT AND CONSTRAINTS

N. C. DATTA
Department of Zoology, University of Calcutta
35 B C Road, Calcutta-700 019

Defining pollution :

Pollution has been defined differently by different authors Holdgate (1979) defined pollution as "The introduction by man into the environment of substances or energy liable to cause hazards to human health, harm to living resources and ecological systems, damage to structure or amenity, or interference with legitimate uses of the environment". This definition explicitly indicates that pollution is a man made phenomenon and obviously, therefore, there cannot be any natural pollution as conceived by some scientists.

Need for monitoring pollution :

During last half century or more land, air and water are getting highly polluted by various human activities (industrialisation, urbanisation, use of pesticides, herbicides and chemical fertilisers, discharge of radioactive substances etc.) which produce harmful substances called pollutants to the environment. Consequently, habitats of all kinds are degraded to a great extent rendering them inhospitable to man and other biota. Some 1500 hundred substances have been listed as pollutants in freshwater which include acid and alkoli, anions (sulphide, cyanide etc.), detergents, domestic sewage, food processing wastes, gases (Chlorine, Ammonia etc.), metals (mercury, lead, zinc, chromium, cadmium, arsenic etc.) oils, pesticides, herbicides, radionuclides and many other substances. Under such circumstances, it is indeed very necessary to monitor and measure pollution so that proper preventive and restoractive measures may be adopted to safeguard the damage to habitat as well as human health.

Kinds of monitoring

Monitoring literally means to keep an eye to an event in order to assess and ascertain its degree of changes if it so happens. It may be done by two methods :

1) Physico-chemical;
2) Biological monitoring.

1. **Physico-chemical monitoring** - It is the direct measurement of pollutiants in a particular environment at a point of time. It determines quantitatively the amount of pollutant in a sample. Such measurements are done either by instruments (thermometer, pH meter, conductivity bridge, colorimeter etc.) or by chemicals (for measurement of oxygen,dissolved free carbondi-oxide, BOD etc.).

2 Biomonitoring - It is a kind of indirect measurement and is done by using various kinds of biota. It is essentially qualitative and one cannot measure the exact amount of pollutants in a system but can get an idea of degree of pollution such high, medium and low.

In order to effectively manage an environment receiving polluting substances it is necessary to know :

i) The substances entering the environment and their quantities, sources and distribution,
ii) The effects of these substances within the environment and
iii) Trends in concentration and effect, and the causes of these changes.

What are bioindicators ?

Literally indicator means one who indicates or points out something. The organisms which very often indicate or identify the pollutional status of a habitat are termed biological indicators of pollution.

Levels of using biological indicators :

It is well known that environmental pollution induces changes in the structural and functional organisation of biological systems and such changes may be from biochemical to community level.

1) Biochemical - Many organisms such as chironomidae, immature *Planorbis* and *Artemia* have the ability to change the concentration of haemoglobin in body fluids in response to changes in environmental oxygen tension. Serium analysis by paper electrophoresis is a promising way of finding an affect of industrial wastes on fishes. Measurements of the accumulation of pollutants by organisms have been used to provide information on concentrations present in the environment. Freshwater mussels make an excellent monitors of pesticide concentration in aquatic habitat.

2) Cells and tissues - By examining the cells and tissues of any organisms exposed to pollutants and comparing those with the similar cells and tissues of organisms from pollution free habitat one can determine the pollutional statics.

3) Species :

a) **Toxicity test** - Toxicity tests involving a number of specific organisms have been done to monitor polluiton. The LC_{50} value has been recommended as an important criterian of toxicity. Instrad of placing organisms in different detutions of an effluent continuous flow

exposure system has been developed. Fish, diatons, algae, snail, *Daphnia* etc. have been used as bioassay organisms.

b) **Species lists -** All most all biological studies of water pollution consisted of listing species present at different sampling stations. The different species of organisms present at smapling stations receiving different degrees of enrichment/effluent are somewhat different qualitatively and quantitatively and thereby indicate trophic or pollutional status

The use of indicator organism requires a knowledge of the ecological tolerances and requirements of species. Species of benthic macro vertebrates have been divided into three groups based on the degree of tolerance. These are - (1) Pollutional or tolerant species, (2) Facultative and (3) Sensitive species.

Pollutional or tolerant species can survive in highly polluted zone. Facultative species can survive over a wide range of environmental conditions, but not in highly polluted zone Sensitive species are clean water species and thus cannot survive in polluted zone.

Instead of basing on the occurrence of a particular species or a particular taxonomic group, association of several taxonomic groups may serve as good bioindicators. This system is based on the observations that a river which has received an input of sewage shows zones of decreasing pollution. These zones are polysaprobic zone (discharge point) which is highly polluted; merosaprobic (less or mildly polluted zone) and oligosaprobic (little pollution or almost clean water zone) and their sequences reflect pollutional status. One the basis of tolerance of saprobity the organisms are classified into four groups.

1) Saprobiontic species - occur in heavily polluted zone,
2) Saprophilic species - generally occur in polluted water but also present in other communities,
3) Saproxenous species - occur generally in biotopes other than polluted ones, but able to survive presence of pollution and
4) Saprophobous species - unable to tolerate polluted environment.

Steps of biomonitoring :

There are three sequential steps in biomonitoring programme. The steps are survey, veillance and monitoring.

Survey is the first step which will apprise the investigator of the general ecological condition of a specified spot. The next step is surveillance which has been defined as the repeated measurements of a variable in order that a trend may be detected. This step is vital. The thirt step is monitoring or the determination of the pollutional status. The vast amount of data produced during surveillance programme is usually subjected to critical analysis and statistical methods are also followed. Various pollutional indices can also be used.

However, the assessment of environmental quality should not entirely depend on biomonitoring. A holistic approach will be judicious and it may be stated that biological-ecological analysis cannot replace chemical, physical or biochemical analysis, but can indeed significantly complement them.

Suggested readings :

Aston, R.J. (1973). Tubificeds and water quality : a review. Environ. Pollut. **5** : 1-10.

Holdgate, M.W. (1979). A perspecitve of environmental pollution. Cambridge Univ. Press.

Manson, C.F. (1980). Biology of freshwater pollution.

Wright, D.A. (1978). Heavy metal accumulation by aquatic invertebrates. Applied Biology, **3** : 331-399.

□

PRESENT POLYCULTURE SYSTEM IN EAST GODAVARI AND WEST GODAVARI DISTRICTS OF ANDHRA PRADESH

D.V. Krishnam Raju
Dept. of Zoology, Ideal Degree College
Kakinada, Andhra Pradesh

Introduction

Till 1994-1995 polyculture means Indian major carps and exotic carps in Andhra Pradesh. After the outbreak of shrimp culture, scientists, farmers and enterpreneurs searched for alternatives which will be viable and profitable to them. Then they thought of fish culture with *Penaeus monodon*. Due to great adaptability to different saline waters, *P. monodon* can survive even in zero ppt saline waters.

Culture practices

(a) Stocking :— In normal fish culture, stocking of fish is 3:4:3 (Catla : Rahu : Mrigala). In shrimp culture-extensive — 1 to 2.5 per sq. mt; modified extensive 5-10 per sq. mt; semi intensive 15-30 per sq. mt. intensive 30-50 per sq. mt. In this type of polyculture 3:5 (Catla and Rohu) plus 0.5 to 0.75 per sq. mt (i.e. 750:1250 number of fish plus 5000 to 75000 of *P. monodon* per hectare).

(b) Preparation of tanks :— Preferably 2 hectare ponds are suitable for this type polyculture. Sun drying is essential. Tilling of the pond and application of lime as per the requirement as in the case of fish culture.

(c) Seed collection :— (a) fish spawn collection from hatcheries; rear them in nursery ponds and transfer them into culture ponds. (b) collection of PL20 shrimp seed from hatchery or natural source; acclamatising them to zero ppt saline waters in nursery ponds for 15 to 20 days, transferring them to fish ponds of 5000 to 7500 numbers per hectare.

(d) Water quality management :— Water should be with less phyto and zooplankton until the shrimp will be harvested i.e. 30 to 40 cms reading of Secchi Disc. Application of lime, Dolomite and Geolite as per the requirement. Pumping of fresh water and dewatering should be done as per the necessity arises.

(e) Precautions :— (1) Application of chemical and organic fertilizers is required, but in a limited quantity only. (2) Growth of phyto and zooplankton growth should be monitored. (3)

Dewatering should be done to maintain the water quality which is suitable to srimp until the shrimp is harvested.

(f) Advantages :— (1) Separate feed need not be given to shrimp as they feed on the left overs of the feed supplied to fish and also feed on semidigested faecal matter of fish. (2) Shrimp culture period is only 70 to 100 days. (3) No financial investment for shrimp culture except seed cost. (4) Less incidence of diseases. (5) From hectare pond shrimp harvest will be 150 kgs within 100 days. Cash realisation out of this produce will be sufficient for the maintanence of pond throughout the year. So, fish produce is net profit to the cultivator.

(g) Disadvantages :— Harvest is very difficult. It is not possible as in the case of shrimp monoculture. By using cast net, partial harvest should be done.

(h) Conclusion :— In view of the less maintanance, less risk and less investment, above all high profit margin, farmers in the above two districts, who are having both fresh and saline water fecilities, are being attracted to go for fish with *P. monodon* instead of pure fish polyculture. Also majority of farmers of the above two districts who constructed ponds exclusive for shrimp culture are slowly changing to this type polyculture if they are having the water fecility as it involves less risk and 90% of guarantee.

Selected References

Training programme on prawn farming and its export prospects, MPDEA (1994). p. 165.
Indaqua (1995). Souvenir (By MPDEA). p. 202.
Manual on shrimp farming MPDEA (1995) p. 98.
A guide on diseases of shrimp MPDEA (1997). p. 48.
Kunihiko Shigeno - Problems in prawn culture (1978). Arvind Publishing Co. p. 103.
Contribution of CMFRI to R & D in Marine fisheries of A.P. p. 26.
Pillai, T.V.R. (1993). Aquaculture principles and practices, Fishing New Books, London, p. 570.

□

INDOOR AIR POLLUTION & GENOTOXICITY

B.C. Behera

Department of Zoology, Kendrapara College,

Kendrapara 754211, Orissa

Air pollution began the day man learned to generate fire, however natural air pollution was earlier limited to forest fires, volcanoes, homefires and did not affect human health a great extent. But now it is so deadly in nature that one in four death of human being is associated with environmental factor. Protecting the environment is a priority for many. A worthy cause indeed. But our own habitat, the home needs as much attention and protection. Several studies say that the air inside our home is worse than the outside. As a result of poor air quality many of us have experienced mysterious symptoms such as coughing, sneezing, sinositis, itchy throat, burning and watery eyes, headache and so also bronchitis and asthma. Many pollutants found in the indoor air are toxic and known to cause cancer. The major source of indoor air pollution is coming from the tobacco smokes, dusts, cooking gas, pertumes, wall painting, household pesticides and latest to join are the mosquito repellents (MRs).

A no. of environmental pollutants has been identified as carcinogenic and mutagenic. There is a good correlation exist between mutagenicity and cancer. The genotoxicity of various chemicals found in the environment has been studied since 3-4 decades. A no. of mutagenic test procedures are now available in different organism starting from bacteria to human beings both *in vitro* and *in vivo*.

Mosquito repellents are now widely used in urban and rural areas to get rid of mosquito bites. Most of these MRs contain a synthetic pyrethroid insecticide, allethrin. The main three different types of MRs are available of coil, mat and vapouriser liquid type. These MRs on heating produce smokes/vapour inside the room to which human beings are exposed for a longer period. I have tested these three MRs for genotoxicity testing in a mammalian test system by using bone marrow chromosome aberration assay and sperm shape abnormality assay.

Three different forms of MRs like ROOSTER, GOODKNITE and ALLOUT were purchased from the local market. A groups of mice were exposed to the smokes of these MR by inhalation process in an inhalation chamber for different duration of times. After exposure, bone marrow cells and sperms were collected and processed for the preparation of chromosomal and sperm slides. Control slides were also prepared from the unexposed animals. Various types of chromosomal aberration and sperm shapes were noticed during examination under microscopes. The frequency of chromosomal aberration and sperm shape abnormality were found to be statistically significant from the respective control value. It was also further noticed that the frequency of induced aberration

was linearly increased with the increase of exposure timings. So the present results indicate that these MRs are no more safe to our genetic material and it is our duty to save them from these unwanted indoor air pollutants.

Selected References

Behera, B.C. (1990). Genotoxicity of pesticides in mammalian cytogenetic test system. Ph.D. Thesis. Utkal University. Bhubaneswar, Orissa.

Sahoo, K. and Das, R.K. (1996). Genotoxicity of mosquito repellent coil in Rat alveolar macrophages. Mutation Research.

Moorthy and Moorthy (1995). Induction of chromosome aberration and micronuclei by a mosquito repellent both in target and non target cells of mice & rats. Mutation Research.

□

ECOLOGY AND ETHOLOGY OF INDIAN BLISTER BEETLE *Mylabris phalerate* (PALLAS) (MELOIDAE : COLEOPTERA)

Anup Duttagupta

Assistant Professor, Dept. of Zoology, Chandernagore College, Govt. of West Bengal, Chandernagore, West Bengal

Blister beetles belonging to the family Meloidae is having many important biological parameters for fundamental as well as applied research. On account of their remarkable life histories (hypermetamorphosis) they are regarded as a unique group. Blister beetles possess a pharmaceutical product Cantharidin in its blood which causes blisters on human skin. The product has long been used in medicine and cosmetics. Many species are harmful pests of agricultural horticultural and vegetable crops but some are beneficial during their larval stage, as they destroy egg masses of Locusts (Crowson, 1955).

In India very little work has been done on this family due to lack of worker. Meloidae remains practically untouched from the oriental region due tc incomplete taxonomic information. Saha (1972, 79,81,89 and 1992) published several papers and a monograph on Meloidae of India and

adjacent countries. The published information on Meloidae is very scattered and hardly reflects the richness of this group.

In this paper steps are taken to study the Ecology and Ethology of Blister beetle *Mylabris phalerata* (Pallas), the most widely distributed species in India. The field investigation was conducted in an area in the vicinity of Jhargram, Dist. Midnapur, West Bengal about 155 kms from Calcutta. The species *Mylabris phalerata* (Pallas) is found in plenty on a shrub commonly known as Ambarilata, *Ipomoea carnea* (Convulvulaceae). In fact no specific Ecological and Ethological observation have been made on these interesting insects in India so far. The population fluctuation has been noticed. The sudden rise in number occurs during mating season. The insects feed on a number of plants' floral part and have a fascination for a particular plant. The feeding as well as mating behaviour of these insects differ in terms of time as well as in terms of host plant selectivity. In fact *Mylabris phalerata* (Pallas) never mate on the plant they feed and never feed on the plant they mate. The observations in the paper have been illustrated by several coloured photographs.

Selected References

Askew, R.R. (1971). Parasitic insects, Heinemann Educational Books, London, P. 1-316.

Balduf, W.V. (1935). The Bionomics of Entomophagous Coleoptera E.W. Classey Ltd., Hampton, Middlesex. England. PP. 1-220.

Crowson, R.A. (1981). Biology of Coleoptera, London Academic Press (C), PP. 1-802.

Saha, G.N. (1979). Revision of Indian Blister Beetles (Coleoptera : Meloidae : Meloinae). Rec. Zool. Surv. India, 74 (Part I). PP. 1-146.

Selander, R.B. (1964). Sexual behaviour in Blister Beetles (Coleoptera : Meloidae) I. The genus *Pyrote*. Can. Entomol. **96** : 1037-1082.

□

THE POSSIBLE MODE OF ACTION OF PROSTAGLANDINS : A STUDY TO ASSESS THE LOCAL EFFECT OF PROSTAGLANDINS E_1 , E_2 OR $F_2\alpha$ IN THE REGULATION OF MALE FERTILITY

Swapan Rej

Dept. of Zoology, Behala College, Calcutta 700 060

Separation of the epididymis at the testis-caput junction in male rats having proven fertility retained the fertilizing capacity of the confined epididymal spermatozoa for about three weeks. Multiple doses of PGE_1 (5 mg/kg) or PGE_2 (10 mg/kg) on days 3, 5 and 7 following the surgical separation of the epididymidis was found to be ineffective in altering the fertilizing ability of the confined epididymal spermatozoa, however, similar PG regimen on days 8, 10 and 12 or 15, 17 and 19 following the surgical manipulation resulted in sterile mating and the females which were inseminated with the test animals became pseudopregnant. $PGF_2\alpha$ (2.5 mg/kg), on the otherhand, in either of the treatment schedules failed to affect the fertility of the test animals. Testis of the animals which had only PGE_1 treatment was found regressed compared to controls. Testosterone replacement concurrently with either of the PGE_1 and PGE_2 regimen maintained fertility of the test animals, however, the regression of the testis caused by PGE_1 was retained. To clarify the local effect of PGs, intratesticular injection of PGs was programmed in one testis leaving the contralateral testis intact. It was documented that PGs irrespective of the type used at a dose of 2.5 mg/kg had differential effect in terms of testicular regression, however, fertilizing capacity of the epididymal spermatozoa of both the injected and contralateral control sides was equally affected except in the test animals which had $PGE_2\alpha$ regimen. Testosterone regimen when programmed along with PGs maintained fertility of the test animals. The biphasic effects of PGs have been explained as the consequence of an inhibition of steroidogenesis in one hand, and on the otherhand, a vascular restriction at the side of its inejction.

Selected References

Rej, S.K.R. and A. Chatterjee (1978). The Possible Mode of Action of Prostaglandins. Int. J. Androl. **1** : 563-69.

Skakkeback, N.E.R., Kely, W. and Corter, C.S. (1976). Prostaglandin concentrations in the semen of hypogonadalmen during treatment iwth testosterone. J. Reprod. Fertil. **47** : 119.

Bygdeman, M., Fredricsson, B., Svanborg, K. and Samuelson, B. (1970). The relation between fertility and prostaglandin content of seminal fluid in men. Fertil. Steril. **21** : 622.

Rej, S.K. and Chatterjee, A. (1980). Antifertility efficacy of Prostaglandins (PGE_1, PGE_2 or $PGF_2\alpha$) in male reproductive physiology. Prostaglandins and Medicine **4** : 465-70.

HUMAN LIVER — ITS FUNCTIONS & DISORDERS

N.C. Maity

Department of Zoology, Ramkrishna Mission Residential College,
Narendrapur, South 24-Parganas, West Bengal

Liver is the largest organ and digestive gland in human body. In an adult man it weighs about 1.5 kg. It is also an excretory and secretory organ. Secretion of the liver is bile which is yellowish-green in color. Average 700 ml of bile is discharged per day. Bile is alkaline, containing water, various inorganic salts, bile salts, bile pigments and other substances. Functions liver is summarised below :—

A. In connection with digestion

Bile salts help in emulsification of fat thus help in its easy digestion and also in absorption of fats.

B. In relation with blood

In foetal stage it is a source of R.B.C. formation but in adult life related with R.B.C. destruction. Liver is a large store-house of blood and site of synthesis of all plasma proteins.

C. In connection with metabolism

i) Non-glucose monosaccharides, lactic acid, pyruvic acid, glycerol etc. are convertd to glucose and also glycogen. Liver controls glycogenolysis, neo-glucogenesis, fat synthesis etc. It also actively controls alcohol metabolism.

ii) It controls deamination, transamination, transmethylation and all types of protein and fat metabolism.

D. In relation with hormone metabolism

Various hormones like oestrogen, cortisol, ADH, insuline, trophic hormones are inactivated and excreted through liver.

E. Detoxication & conjugation

Various drugs like hexobactitol, pethidine, chloramphenicol, benzoic acid etc. are excreted by above mentioned processes.

F. Relation with excretion

Heavy metals, toxin, bacteria etc. are also excreted from the body.

Disorders of Liver

Most of the diseases of liver are due to damage of parenchymal (hepatic) cells due to infection of virus, protozoa, bacteria, helminths etc. These infections cause metabolic dysfunctions or biliary secretary dysfunctions. Jaundice is most common disese of the liver. Commonly 3 types of jaundice are known.

(A) Haemolytic jaundice

This is due to damage of R.B.C.

Causes :— i) congential spherocytosis,
ii) sickle cell anaemia,
iii) thalassaemia
iv) poison
v) incompatible blood transfusion
etc.

(B) Hepatocellular jaundice

This is usually due to damage of parenchyma by toxic or infective agents.

Causes :— i) infection of virus - types A & B etc.
ii) Leptospirosis - yellow fever.
iii) toxic subtances - carbon tetrachloride, chloroform, arsenic, sulphonamides, paracetamol, over indulgence on alcohol etc.

(C) Obstructive jaundice

It occurs when there is a block to the pathway between the site of conjugation of bile in liver cells and the entry of bilirubin into duodenum. It may be of two categories (a) extrahepatic cholestasis, (b) Intrahepatic cholestasis.

Selected References

Chatterjee, C.C. (1994). Human Physiology, 11th edn., Medical Allied Agency, Calcutta.

□

DEFENSIVE BEHAVIOUR IN PRAYING MANTIDS (DICTYOPTERA : MANTODEA)

Shekhar Mukhopadhyay

Assistant Professor of Zoology, Hooghly Mohsin College, Chinsurah, Hooghly

Praying mantids are found mostly in tropical and subtropical countries. Most of the smallest are about an inch long. They have narrow, feathery forewings and large fan shaped hindwings, which are folded beneath the forewings when not in use. About 2250 species are known world wide. They are quite well known to the naturalists for their habit of cannibalism as well as predatary role in natural control of lots of pest of agricultural importance. They exhibit various forms of curious behaviour at various steps of development, courtship, feeding, mating and oviposition.

The behaviour may broadly be classified into four categories as primary defensive secondary defensive, prey capture and feeding and reproductive behaviour, often one type of behaviour may be seen to overlap other forms. Here we are concerned with only primary and secondary defensive behaviour of praying mantids. Varley (1939) and Robinson (1969) recognise two types of antipredator adaptations :

(a) Primary defensive adaptations - which reduced the probability of a predator initiating a prey - capture attempt.

(b) Secondary defensive adaptations - which only operate after a prey capture attempt has been initiated and which reduce the probability of its being successful.

Primary defensive adaptation or behaviour are found in both Nymphhal stages are adults. The nymphs show ant mimicry, startle display (may also be categarised under secondary defensive adaptation), dead mimicry, bark, leaf, stick, flower, grass and other objects or even ant gall.

There are also natural selections by which a tendency towards wing reduction is evolved.

In adults, the primary defence mechanism is mostly concealment among twings, running (also found in nymphs), jumping and flying. Sound production also may be recognised as defensive mechanism.

Primary defensive adoptations include all forms of camouflage, warning colouration and colour-mimicry since these prevent a predator from attacking prey and/or provide some time to escape from enemy.

Secondary defensive behaviours or adaptation includes display of various warning colours on specific parts of the body. These are called startle display and is done only when primary defensive machanism fails or willingly to maintain territoriality, attraction for mate, distract an invader

etc. Some species also have thanatosis (death feigning), flash colouration and chemical defence (regurgitation of fluid from the month) as Secondary defensive behaviour.

The final defensive adaptation is overt attack, this may occur from the startle posture by striking at the stimulus source with the clawed farelegs, or it may occur when the mantid is held by the predator, in which case it bites with its jaws as well as scratching with the claws.

These interesting, primitive and rare insect may face the threat of extinction for many a reasons including their high degree of specialization and nature of cannibalism. We should carefully conserve these highly predatory insects as an unique agent of biological control for agricultural pest management programme.

Selected References

Audinet-Serville, J.G. (1839). Histoire Naturelle des Insects. Orthopteres. Paris. 776 pages.

Balderson, J. (1984). Catalogue of Australian Mantodea. Tech. Paper Div. Entomol. CSIRO, Australia.

Beier, M. (1931). Neue und Seltene Mantodeen aus dem Zoologischen Staatsinstitut und Zoologischen Museum in Hamburg. Mitt. Zool. Stinst. Hamburg., **45** : 1-21.

Beier, M. (1937). Results of Oxford University Expedition to Sarawak (Borneo) 1932. Mantodea. Proc. Roy. Entomol. Soc. London., (B) **6** : 177-181.

Burtt, E. (1943). The defensive attitude of the mantid Idolum diabolicum Saussure. Proc. Roy. Entomol. Soc. London, (A) **18** : 57.

Edmund, M. (1972) (1976). Defensive behaviour of Ghanaian Praying mantids. Zool. J. Linn. Soc. **51** : 1-32 and **58** : 1-37.

Wood-Mason, J. (1891). A calalogue of the Mantodea ..... in the collection of the Indian Museum. No 2 : 49-66, Calcutta.

Mukherjee, T.K. and Hazra, A.K. (1985). Insecta : Mantodea. Rec. Zool. Surv. India, **82** (1-4) : 33-39.

□

AN INTRODUCTION TO CANCER

Lalita Das (née Singhania)
Maharaja Manindra Chandra College, Shayam Bazar, Calcutta

The mitotic cell division is a natural process in multicellular organisms. Due to the function of regulatory genes, cell division and cell cycle is completed. If there is a mutation in regulatory genes, the cells start to divide rapidly and in uncontrolled fashion which may create an abnormal condition called cancer or malignancy. The cells those are responsible for such condition are tranformed neoplastic cells whose growth, division and developmental nature is totally different than normal cells. When such neoplastic cells pile up to form irregular masses of cells are called - tumours. These tumours are of two types; benign and malignant. In case of benign tumours, the neoplastic cells remain at their place of origin are less harmful tumours but may be dangerous if form in the brain. Whereas in case of malignant tissue, the cells detach from their place of origin and move away somewhere else in the body to establish new colonies there. Malignant tissues may cause the death of the organism.

More than 200 cancer have been identified and were grouped in four main groups like Carcinoma, Sarcoma, Lymphoma and Leukemia. Carcinomas are the tumours of epithelial cells, Sarcomas are the tumours of mesodermal cells, Lymphomas are the tumours of lymph nodes and spleen and Leukemia is caused due to cancer of blood cells.

Different studies show that cancer cells are different than normal cell in many respects, for example cancer cell can survive for unlimited period of time, movement and mitosis is not inhibited when they come in close contact and can invade other normal tissues to form tumours there.

Cancer may occur spontaneously, or may be due to a chemical and most commonly due to the infection of tumour viruses. Cancer causing Oncoviruses are of two types, RNA and DNA. Some of the important DNA Oncoviruses are Papilloma virus, Parvo virus, Adenovirus and important RNA viruses or reproviruses are Rous Sarcoma Virus, Murine Sarcoma virus etc.

Some chemicals can also induce the transformation of normal cell into malignant cell by disturbing normal function of the genes, for example Benzidine, Arsenic etc.

Usually multiple changes are necessary to create a cancer and acute transforming viruses are tissue specific in nature.

Selected References :

Benjmin Lewin. (1994). Genes-V. Oxford University Press.

DeRobersis, E.D.P. and DeRoberts, E.M.F. (1995). Cell and Molecular Biology, Holf-Saunders International Edition. 8th Edition.

□

THE CRETACEOUS - TERTIARY BOUNDARY AND THE EXTINCTION OF THE DINOSAURS

N. Ghorai

Department of Zoology, Hooghly Mohsin College, West Bengal

The dinosaurs have been considered to be originated at the late Triassic, about 230 Myr age. It, with some vertebrate and invertebrate groups, died out 66 Myr ago at the Cretaceous - Tertiary boundary after a long reign of 165 Myr. Over the years, hundreds of theories for this disappearance have been proposed, and yet none has gain the general acceptance. There are several key problems in accounting this extinction episode. The two most tenable, current theories to explain the K-T event are the 'Catastrophist' extra-terrestrial model (Alvarez, 1987), and the 'gradualist' ecological succession model (Van Valen, 1984). The first model explains the disappearance of the dinosaurs as a result of the aftereffects of a major extraterrestrial impact on the Earth and the evidence is essentially geochemical and astrophysical. The gradualist model postulates a decline caused by long-term climatic changes, in which the stable subtropical, lush dinosaurian habitats gave way to the strongly seasonal, temperate, angiosperm-dominated mammalian habitats. The evidence for this hypothesis is mainly palaeontological and stratigraphic. A 'catastrophist' would envisage that the main extinction event lasted less than say a year, while a gradualist would regard the time span as more than say 1000 years.

Nineteen 'families' of dinosaur are known from the last 20 Myr of the Cretaceous, and they had all disappeared by the K-T boundary. Four of these 'families' are known only by single species each. Of the remaining 15 families, two died out before the Maastrichtian three in the early Maastrichtian (72 Myr ago) two in the middle Maastrichtian (70 Myr ago), and eight in the K-T boundary. These eight latest surviving dinosaur families were represented by only 12 species (Sloan *et al.*, 1986, Sullivan, 1987). Both the 'gradualist' and 'catastrophist' models can be combined to explain the long-term declines and instantaenous disappearance at the K-T boundary respectively. After the extinction episode since K-T boundary mammals proliferated to their present day diversity.

Selected References :

Alvaez, L.W. (1987). Mass extinctions cused by large bolide impcts. *Physics Today*, July 1987, 24-33.

Sloan, R.E., Rigby, Jr., J.R., Van Valen, L.M. and Gabriel, D.. (1986). Gradual dinosaur extinction and simultaneous ungulated radiation in the Hell Creek Formation. *Science*, **232** : 629-33.

Sullivan, R.M. (1987). Reassessment of reptile diversity across the Cretaceous-Tertiary boundary, *Contr. Sci. Nat. Hist. Mus. Los Angeles Co.* **391** : 1-26.

Van Valen, L.M. (1984). Catastrophes, expectations and the evidence. *Palaeobiology*, **10** : 121-37

□

BIOINDICATORS OF POLLUTION

Dhananjay Mishra
Asstt. Professor in Zoology, Govt. J.M.P. College,
Takhatpur, Bilaspur, M.P.

In recent times, pollution of our environment in which we are living, has become a point of concern for both developing and developed countries. Nowadays we often see seminars, symposia, workshops to occur in every year to two. We hear from every nooks and corners of the world, the cry of pollution. Scientists defined Pollution as any physico-chemical or Biological change in the characteristics and constituents of the Biosphere which directly or indirectly affects the existence of man. Although the awareness to the environment has been started in 1948 with United Nations charter : The establishment of IUPN (the International Union for the Protection fo Nature), the actual "Blueprint for survival" has come to the world's forefront in 1972 at Stockholm (Sweden) when UNEP (United Nations Environment and Protection) was set up.

In this respect Bioindictors of pollution has become relevant and of great concern to the scientists involved. Many Physiologists, Taxonomists, Sanitary Biologists, Limnologists have been involved to assess the pollutional stage of the degrading environmnt (i.e. water, air, soil). Biologists, turned taxonomists, perceive Bio-indicator as any species, plant or animal type which show specific sensitiveness or Tolerance in response to the change in the quality of the environment.

Among plant kingdom, many bacteria such as *Salmonella, Streptococeus, Enterococci, Escherichia coli, Photobacterium phosphoreum,* phytoplanktons, Diatoms, yeasts and many fungal forms such as *Saprolegnia, Phythium, Aphanomyces* serve as good indicator of pollution. Among animal kingdom many Protozoans (mainly ciliates, flagellates), Planarians, Chironomids, Tubifeces, Crustaceans, Vertebrates (fishes and amphians) indicate the degradation of environment.

Limnologists have devised an unique "Saprobien System", in a streamlined aquatic system. They have referred different zones, each specific with specific species. Polysaprobic zones are highly polluted zone receiving organic and inorganic wastes with high BOD and high abundance of bacteria, planktons, yeasts and ciliated Protozoans. Such organisms are commonly called as saprobiontic species. Saprophilic species such as Flagellates and Planktons are found to occur in Mesosaprobic zones where BOD is moderate and dissolved oxygen is higher than the previous zone. Saproxenous species are listed with Planarians, Crustaceans and some fishes and the zone is oligosaprobic zone. Katherobic zone is more or less clearer zone with high dissolved O_2 and BOD is low. Such zone is enriched with Saprophobus species.

From the above discussion, the scientists have identified the living organisms and the type of Environment they live in. Physiologists have worked in this connection to relate the types of disease prevalent among the particular type of environment. They not only analyze physical and chemical nature of the habitat but also the physiological and pathological changes in the living organisms. Susceptible species are more affected and hence their loss in number or even disapearence may lead to the conclusion that environment is polluted. On the contrary, some tolerant species may increase their number in the polluted atmosphere. Their abundance will raise them into the status of Indicator Species.

Selected References :

Fjerdingstad, E. (1964). Pollution Streams Estimated by Benthal Phytomicroorganisms. I. A..Saprobic system based on communities of organisms and Ecological Factors Int. Rev. Gesamten. Hydrobiol. **49** : 1.

Collier, T.K. and Varanasi, U. (1991). Hepatic activities of xenobiotic metabolizing enzymes and biliary levels of xenobiotic in English sole (*Parophrys vetulus*) explosed to environmental contaminants. Arch. Environ. Contam. Toxicol. **20** : 462-73.

□

ORGANELLE GENOMES

Chandana Naskar

Department of Zoology, Netaji Nagar College for Women

Regent Estate, Calcutta-700 092

Most heritable traits are controlled by nuclear chromosomal genes, but some depend on DNA in cytoplasmic organelles. Mitochondria and chloroplasts carry small amounts of unique DNA that behave independently with respect to nuclear genes. These cytoplasmic organelles have presumably evolved from free-living bacteria and algae, respectively. Mitochondria and chloroplasts both represent membrane-bound systems in which some proteins are synthesized within the organelle, while others are imported. The organelle genome is usually a circular DNA that codes for all of the RNAs and for some of the proteins that are required.

Mitochondrial genomes vary greatly in size from the 16 kb minimalist mammalian genome to the 570 kb genome of higher plants. Chloroplast genomes range from 120-200 kb. In both

mitochondria and chloroplats, many of the major proteins contain some subunits synthesized in the organelle and some subunits imported from the cytosol.

Mammalian mt DNAs are transcribed into a single transcript from the major coding strand, and individual products are generated by RNA processing. Rearrangements can occur in mitochondrial DNA rather frequently in yeast, and recombination between mitochondrial or between chloroplast genomes have been found.

Mitochondrial genes show maternal inheritance, because mitochondria are centributed entirely by the ovum and not at all by the sperm. Thus the mitochondrial genes are derived exclusively from the mother, and in males they are discarded each generation.

Selected References :

Benjamin Lewin (1997). Genes VI. Oxford University Press, London.

DeRobertis, E.D.P. and DeRobertis, E.M. F.Jr. (1995). Cell and molecular biology. 8th edn. B.I. Waverly Pvt. Ltd., New Delhi.

Gardner, E.J., Simmons M.J. and Snustad, D.P. (1994). Principles of Genetics. 8th edn., John Wiley and Sons. Inc.

Strickberger, M.W. (1994). Genetics. 3rd. edn. Prentice-Hall of India Pvt. Ltd.

IN SEARCH OF LIFE : FACTS AND FINDINGS

Tushar K. Mukhopadhyay

Department of Zoology, Hooghly Mohsin College,

Hooghly, West Bengal

Our solar system, about 4.5 billion years old, is expanding. Either "Big Bang" or "Oscillating Universe" theory believe that all matters evolved within next three minutes.

The search is still going on to understand for how primitive life originated. Earlier "Hypotheses" were based on assumptions. Interestingly current theories can not account, because all are based on assumptions. Notable workers are Haldane and Oparin (1920), Harold Urey (1950), Millar and Urey (1953), Manfred Schidlowski *et al.* (1979), Bartusiak (1981) and others.

There are two school of thoughts. Both are strong in providing raw materials in evolution of prebiotic life, however, both agree in chemical evolution as pathway to prebiotic life.

Evidences are gathering and trying to find the most primitive life on earth. So came geo-chemist, paleontologist etc. Although the stromatolites of Australia is oldest one, some evidences (indirect) favour origin of life just after 700 m.y. of origin of earth.

Studies are also conducted on ISDP, comets, and other intersteller objects in search of raw materials of life. This is coupled with the search of life and life supporting environment in other planet / galaxies (if possible to think of !).

. Chemical Evolutionists believe the presence of concentrated raw materials in a reducing atmosphere where ambient temperature fall below 100°C. Fall of temperature is due to numbing cold of interstellar space that facilitated cooling of earth's atmosphere. This also helped formation of water which logged in pits on earth. Thus the pits were full of raw materials not used up by anything. These undergone numerous permutation and combination leading to formation of short-lived proteinoids with an outer core and fluid interior. These were subjected to natural selection by favouring long-lived one, particularly those showing catalytic power.

Then (there is a long gap to solve how) reactions took place in those 'tempest-tossed' days to produce self replicating protein-enzymes to be probably RNA in nature.

Thereafter, the story becomes easier to understand. RNA gave rise to DNA and protein, also tRNA, genetic code and all. Scientist believe that self-splicing nature of RNA and exon/intron structure was a probable way to the origin of self-perpetuating organism.

There is also a common opinion that the first organisms were anaerobic and heterotrophic from which aerobic autotrophs evolved.

Finally, it appears from foregoing account, that we are bound to assume 'what might have happened' rather than 'what happened' on earth in those days. However, it is very hard to believe that (a) life originated quite quickly (within 700 m.y. after birth of earth), but how it became possible, and (b) in vitro synthesis of RNA/DNA today may be a trick in some way or other that was played by the ultimate playful kid on the virgin earth.

Selected References

Attenborough, D. (1979). Life on Earth, England, Collins.

Dickerson, R.E. (1978). Chemical evolution and origin of life. Sci. Am.

Fox, S. and Dose, K. (1986). Molecular Evolution and the origin of life. W.H. Freeman & Co.

Oparin, A.I. (1969). Proc. 1st. Int. Sym. on origin of life. Oxford.

Zaug, A.J. and Cech, T.R. (1986). The ..... enzyme. Science, 231-470.

□

"COMMON-SENSE" ITS COMMONNESS, IMPORTANCE AND SIGNIFICANCE

Prasun Kr. Banerjee
Department of Zoology, Sree Chyatanya College,
Habra, 24-Pgs. (N)

Common-sense, a very common and unique faculty of human being cann't be defined universally, but is applied at right time at the right place in day to day life. It merely be defined as "a faculty, which combines natural instinct, observation, experience, to find workable solution for various situations without using too much brain power."

Is it common to all ?

The very word leads to the generalization that it should be present commonly in all, but time to time it becomes very uncommon, even in genius, well-educated, learned fellows.

Relation to other factors

Common-sense is related to instinct, knowledge, wisdom, experience, perception, intelligence and strongly with logic and judgement and with other factors. Controlled by logical part (left) and intuitive part (right) of brain.

It's changes and development

Common-sense, as related to many factors, so it changes with the development or changes of related factors. As old knowledge replaces new. As for example, the very old idea was that **prick, blister from burn** (old common-sense), but it is changed to new that don't prick, it is **natural protection.**

An event or say a happenings like "doctors thriving in city" this observation will be concluded by common people as "more doctors means better health" but by critical observers "more doctors means sick city".

Effect on mental development

Common-sense effects the development of power of analysis, synthesis, judgement etc. when practiced actively. Common-sense helps to develop social interaction also. Development of IQ, memory (STM or LTM) are also generated by common-sense and vice-versa.

Importance

It is of vital improtance in life. It ensures smooth, safe living. Our sphere of sense also grows larger and larger by the application of common-sense.

Common-sense leads to acquire knowledge in understanding form, e.g. such as basic function of "**digestive system**" can be applied to know diversity in the system, in various organisms. Judgement-Action i.e. 'J-A' complex used common-sense during puzzling situation.

So common-sense is a very important aspect of our human quality, which should be developed and implimented to cope with new complex world; Ofcourse to welcome the 21st century to sustain bio-diversity in deeper sehse.

Selected References :

Ray, H.S. and Thakur, R.S. (1998). Sc. Reporter, March '98. C.S.I.R.
Gomothy-Gopinath (1996). Brain, NBT, New Delhi.

□

STUDY OF POPULATION DENCITY AND EFFECTS OF NON-PHLEBOMINE PSYCHODIDE (DIPTERA, NEMATOCERA) ON MAN IN SOME DISTRICTS OF WEST BENGAL

Madanmohan Ghosh

Department of Zoology, Barasat Government College,
Barasat, North 24-Parganas, West Bengal

Non phlebotomine Psychodide or "Roof-moth" or "Moth flies" are mostly found in high rain fall areas where there is an abundance of decomposing organic material. They are mostly common in moist wood or forests but a great number of species occur in all around such man made habitats as heaps of garden rubbish, drains, septic-tank, bathrooms, kitchen and margins of stream, ponds, lakes that are polluted with decaying matter and their wide distribution is presumably due to ready availability of such habitats in India.

Adults may be recognised by the following features :

Small, short-bodies, weekly flying Nematocera with a dense vestitute of hair and scales; compound eyes present. Wings with costa extending around marign to the anal region, discal cell absent, longitudinal veins well developed, cross veins often indistinct, usually restricted to basal third of the wing; M- always 4-branched, and the veins rduced. Metanotum enlarged, projecting posterior to the abdomen cavity to the level of second or third segments

The larvae are elongated, amphipneustic forms, often darkly pigmented, usually with respiratory siphon at the tip of the abdomen with each abdominal segment sub-divided into 3 annuli.

The interesting point is that the ovaries mature in the pupal stage and multiple copulation occurs in adult. But the observable point is that the spermatozoa are not stored in the female but are provided at the time of copulation by male.

In India Brunetti (1908-1912) and Annandale (1902-1911) initiated work on family Psychodidae at Z.S.I., Calcutta. Recently Ipe. M. Ipe, Ram Krishore (1980-1986) worked on the Indian Psychodidae and added 30 more species in 12 genera.

The population dencity of "Roof-moth" depends on the available food, suitable external and other factors.

The present survey work made in the districts of North and South 24-Parganas, Howrah, Midnapore and Darjeeling of West Bengal. It is noted that with the increase of population, inadequate sanitary system, discharge of excretory and faecal matters of man and liverstocks in open places and in uncovered narrow drains, disposal and domestic and industrial refuges, garbages of building matrials and man made unhygenic condition, the population dencity of "Roof-moth" is increased.

Though they are not blood-suckers, but they act as mechanical vector of protozoan, bacterial, viral and other helminths born diseases of man. Some of the species causes ocular myasis. Therefore, proper attention is required to control their population.

Selected References :

Annandale, N. (1910). A new genus of Psychodid Diptera from the Himalayas and Tranvanore : Rec. Ind. Mus., **5** : 141-44.

Brunetti, E. (1908). Indian Psychodidae. Rec. Ind. Mus., **2** : 369-84.

Duckhouse, D.A. (1973). Family Psychodidae : A catalogue of the Oriental Region, Dolfinaete, M.D. and Hardy, D.E. (Eds), **1** : 226-54.

Johnson, J.W.H. (1914). Contribution to the Biology of Swage disposal. Journal of Economic Biology, **9** : 105-24, 127-64.

□

REPLICATIVE AND TRANSCRIPTIVE CHANGES IN CHROMATIN STRUCTURE FOLLOWING HEAT SHOCK IN *Drosophila melanogaster*

Swagata Chattopadhyay

Department of Zoology, Scottish Church College,

1 & 3 Urquhart Square, Calcutta -700 006

Cellular repsonse to elevations in environmenal temperature is manifested at different levels of gene activity and is collectively known as the heat shock response. The analysis of cellular response to strews owes its beginning to the discovery by Ritossa (1962) that specific puffs in the polytene chromosomes of *Drosophila* could be induced by a brief heat shock.

The heat shock genes are a set or family of genes which have been found in almost all lower and higher organisms ranging from yeast, bacteria, slime mold *Dictyostelium discoideum* to mammals and brids.

The main events of the heat shock response constitute the activation of a specific set of genes referred to as "heat shock genes" with a rapid translation of their transcripts into heat shock polypeptides and concurrent cessation of ongoing transcriptional and translational activities.

The translation products of these genes, the heat shock proteins or (hsps) are believed to provide protection to the cell against adverse effects of stress in an as yet poorly understood manner, and have an important role in normal development and activities of cells (Ashburner and Bonner, 1979; Bienz, 1985). Structure and function of these generally conserved genes have been analysed at the molecular level in diverse prokaryotes and eukaryotes (Lindquist, 1986; Bond and Schlesinger, 1987; Bienz and Pelham, 1987).

In Drosophila, formation of puffs at specific chromosomal sites is correlated with high transcriptional activity (Pelling, 1970). Major heat shock puffs are located at 63 BC locus of left arm of chromosome 3 and 87A, 87C, 93D and 95D locus of right arm of chromosome 3, in *D. melanogaster*. Other minor heat shock puffs are located at 64F, 67B and 70A of 3L.

A consensus sequence was identified upstream of the TATA box which acts as regulatory element (HSE). A protein factor (heat shock transcription factor), HSTF binds to HSE during heat shock to induce transcription of the gene located downstream (Bienz, 1985).

^{3}H uridine autoradiography of heat shock genes reveal that when *D. melanogaster* larvae are shifted from their optimum rearing temperature (25°C±1°C) to a temperature of 38°C, all the above mentioned heat shock puffs are induced, while at 33°C, all except 63BC puff is induced, as depicted in their salivary gland polytene chromosomes.

^{3}H-TdR autoradiography of polytene chromosomes show 3 types of labelling pattterns pertaining to the three phases of replication - (i) the initial phase showing label on interbands and puffs with bands unlabelled, (ii) the mid-replication phase where entire chromosome appears labelled, and (iii) the terminal phase of replication where only bands and chromocentre has label with puffs and interbands remaining unlabeled. Following heat shock, frequency of different labelling patterns show a drastic reduction in the overall number of nuclei showing initial phases of replication, and marked increase in nuclei with terminal patters. This may be due to the fact that as heat shock primarily inhibits ongoing transcriptional activities of non heat shock loci, it may also inhibit synthesis of the RNA primer or any other factor needed for replication, but chain elongation or termination of replication remain unaffected by heat shock in *Drosophila*.

Selected References

Ashburner and Bonner (1979). The induction of gene activity in *Drosophila* by heat shock. The cell, **17** : 241-254.

Bienz (1985).Transient and developmental activation of heat shock genes.TIBS.April,pp.757-761.

Bienz and Pelham (1987). Mechanism of heat shock gene activation in higher eukaryotes. Adv. Genet. **24** : 31-72.

Bond and Schlesinger (1987). Heat shock protein development. Adv. Genet. **24** : 1-29.

Lindquist (1986). The heat shock proteins. Ann. Rev. Biochemistry, **55** : 1151-1191.

Pelling (1970). Puff RNA in polytene chromosomes. Cold Spring Harbour Symposia. Quant. Biol. **35** : 521-531.

Ritossa (1962). A new puffing pattern induced by heat shock and DNP in *Drosophila*. Experientia, **18** : 571-573.

□

PERSPECTIVES IN CHROMOSOME STRUCTURE AND FUNCTION

Chinmoy Sekhar Sarkar

Department of Zoology, Brahmananda Keshab Chandra College, Calcutta -700 035

The chromosomes is the carrier of genetic information in the form of nucleotide sequences and the information is divided into units called genes, many thousands of which are arrayed along the length of the chromosomes. Genes specify polypeptides (proteins) which in turn carry out cellular functions. Human genome contains about $3x10^9$ base pairs and code for 40,000-100,000 genes whereas the so-called chromosomes in virus and bacteria appeared to be simple with less number of nucleotides and in most of the cases circular. The chromosomes of higher cells are composed of the substance called chromatin, which were observed under electron microscope as linear arrays of spherical particles about 100 Å in diameter connected by thin strands of apparently naked DNA described as "particles-on-a string", thus, provides a visible reality of the idea "beads-on-string". The chromatin fibre consists of the nucleic acid DNA and protein which more abundantly of histones. It has been stated in regard to nucleosome model that the structure of the 100 Å wide chromatin with 165 nucleotide pair stretches of DNA wound on a series of beads known as the Octamer that determines the architecture of the nucleosome. Octamers composed of two molecules each of the four histones H2A, H2B, H3 and H4. A molecule of the fifth histone H1 is bound to the exterior of each subunit at the point where the DNA exists. The C-terminal tail of H1 interacts with DNA in the linker region; the length of linker DNA can vary from 0 to 80 base pairs. The polynucleosome filament is further compacted *in vivo* by coiling to form a solenoidal structure with about six nucleosomes per turn. The resulting fibre is about 300 Å in diameter and forming the metaphase chromosomes through different folding in eukaryotes as explained in folded fibre model.

The study of chromosomes is utilized in resolving many problems. In the field of mutagenesis, the different protocols are employed in assaying the environmental mutagens and carcinogens. The structural study of chromosomes deploying different banding techniques reveal the distribution pattern of constitutive heterochromatins (both intercalary and centromeric) which are important in deducing the structural changes of chromosomes homogenity and heterogenity as well as accompanied by the evolution of species and subspecies.

The development of new techniques for acurate chromosome analysis could be prepared from normal stained as well as Q, G, C banded chromosomes using chromosome image-analyzing system (CHIAS), correct estimation of DNA contents and sorting of chromosomes can be done

using flow cytometry. Pulse field gel electrophoresis (PFGE) can be used for separating large molecules of DNA while polymerase chain reaction (PCR) can be utilised for a variety of cytogonetic studies. In some cases, these studies are facilitated by the use of fluoresence *in situ* hydridization (FISH) and genomic *in situ* hybridization (GISH). DNA cloning, DNA sequencing and recombinant DNA technology are the developments radically altered the field of genetics, opened up new vistas in understanding / resolving many issues like human genetic disorders, improvement of desired plants and animals, genetic aspects of immune systems, revealing new sources of genetic variation accelerating map construction of a specific human chromosomes.

Selected References :

Felsenfeld, G. (1992). Nature **355** : 219-224.

Gilbert, W. (1991). Nature **349** : 99.

Jauhar, P.P. (1996). Methods of Genome Analysis in plants (Ed), CRC Press, USA.

Kornberg, R.D. and Klug, A. (1981). Sci. American **244** : 48-64.

Manna, G.K. (1996). In "Trends in environmental mutagenesis" Narosa Publishing House, New Delhi, pp. 271-294.

Manna, G.K. and Sarkar, C.S. (1998). In "Perspectives in Cytology and Genetics", **9** : 383-398.

Sarkar, C.S. and Manna, G.K. (1989).. In "Perspectives in Cytology and Genetics", **6** : 389-401.

Thomas, J.O. (1983). In "Eukaryotic Genes, their structure, Activity and Regulation". Butterworths, London pp. 9-30.

Van Holde, K.E. (1989). Chromatin, Springer, New York.

□

LAC CULTURE : ITS COMMERCIAL IMPORTANCE

Papiya Lahiri

Department of Zoology, Rammohan College, Rammohan Sarani, Calcutta -700 009

References to lac and its various commercial uses dates from antiquity. Lac, a resinous secretion of a tiny insect *Laccifer lacca*, is one of the most versatile resins of animal origin. The insect is parasitic on certain trees and grown in Bihar, Madhya Pradesh and some other Indian States, also in Burma and Thailand. The trees on which lac insects are commonly found are

Palas, Ber & Kusum. Lac is collected by letting off the encrusted branches which are then scrapped to remove the lac or chopped into small pieces.

Lac is an export oriented product and the bulk produced in India is exported to foreign countries chiefly to U.S.A., U.K., West Germany and U.S.S.R.

The industry refining

Stick lac i.e. lac as obtained from the host trees contains dyes, waxes, lac-resin itself, albuminous matters and extraneous impurities.

Seed-lac : Sticks, stones etc. are removed as far as possible by crushing, sewing and winnowing and washing out the dye with water yields the semi-refined product known as seed lac.

Shellac : Further purification to shellac is carried out by several modern methods to yield the refined product in the form of thin sheets which when broken up into flakes forms the shellac of commerce. Shellac is either hand made Shellac or machine made shellac. The refined product is marketed in various forms of purified lac - orange, lemon, Button lac, Garnet, Dewaxed and Bleached lac.

Allied products : Lac is a thermoplastin resin a solid solution of monobasic and dibasic hydroxyacids. About 30% of these acids is Trihydroxypalmitic acid named **Aleuritic Acid**. The pure acid is obtained by the recrystallisation of the technical product from aqueous alcohol. It is moderately soluble in lower alcohols. By virtue of being an excellent starting raw material Aleuriter acid is used in teh fields of perfumery and Pharmaceuticals for the synthesis of civetone, exaltone, ambretlotede having musk like odour for the perfumery industry, various bioactive compounds like prostaglandeis, pheromones, JH, nutritive medicines etc.

Lac wax : is second only to carnauba wax in hardness and polishing value (80°-84°C Melting Point).

Some of the main uses of lac are :

French Polishes, Furniture finishes pharmaceutical and confectionary glazes, Electrical insulation, Moulded articles etc. Evaluation result of the field trials conducted under varied agro-climatic condition have established that the lac-coated urea fertilizer can be used as an efficient slow-release form of urea as leasal in Kharif paddy crop. This minimises wastage and loss of urea increasing its efficiency.

Lac culture besides being economically useful, moisturise the atmosphere by their transpiration thereby reducing acidity and maintaining ecological balance. It is therefore, heartening for those concerned with the health and future of lac, that lac is hail and hearty to serve mankind for many years to come.

Selected References :

Bose, P.K., Sankaranarayan, Y. and Sengupta, S.C. (1963). Chemistry of Lac, 75.Ind. Lac. Res. Inst., Namkun, Ranchi.

Singh, H. (1966). Chemical study of some components of lac larvae, lac resin and lac host. Ph.D. thesis, Delhi University, Delhi.

Indian Shellac (1983). Journal of Shellac Export Promotion Council. October-December. B. Basu, 14/1B, Ezra Street, Calcutta-700 001.

□

SCANNING ELECTRON MICROSCOPY FOR THE BETTER UNDERSTANDING OF INVERTEBRATE HAEMATOLOGY

Snigdha Dass

Department of Zoology, Victoria Institution, 78/B, A.P.C. Road, Calcutta -700 009

The limitless possibilities of the SEM in invertebrate haemotology have been evaluated in case of *Lamellidens marginalis*. A freshwater bivalve of commercial value in India. The object of the present work is to justify the importance of this instrument in the elucidation of the surface and sub-surface ultrastructural features. Haemolymph cells in the present study were fixed in ice-cold 1% glutaraldehyde in phosphate buffer (pH 7.2-7.4) dehydrated through graded alcohol and air-dried in a vacuum desiccator. The cells were coated with thin layer of gold-palladium alloy (150 Å) and subsequently examined in scanning Electron Microscopes (S4-10 and S-600 type of Cambridge Instrument Company, PSEM 500 model of Philips Company.

Four major types of haemolymph cells have been observed in *Lamellidens marginalis* on the basis of their cell surface and cytoplasmic or pseudopodial processes (1) *A)* Agranulocytes are characterised with (a) wavy and folded surface, (b) pores and holes on the cell membrane and with the production of considerable varieties of cellular processes which greatly differ in their shapes, sizes and forms and presumbaly in their function. In a few individuals lobopods produce knob-like structure at the base prior to its bifurcation at the tip. This plasticity in the formation of differing kinds of pseudopodia in a singular variety of haemolymph cells is highly indicative of this organelle's diverse roles such as exploration, hunting for food, locomotion, defense and adhesion in the medium or on the substratum, etc.

B) Agranular forms with the eccentric nuclei are characteristically smaller entities with strikingly smooth surface. These small cell-types may have nucleus with a notch at the middle. These cells are assumed to be hyalinocytes and have been observed to produce blunt pseudopodia.

(2) Granulocytes resemble the agranulocytes by their shape and size but they are distinct with the possession of cytoplasmic granules of three different varieties : a) round, b) elliptical and c) forms with uneven shapes. The orientation, shape and size of the granules vary greatly in amoebocytes in different physiological stages. Exocytosis of granules in this cell-type has often been seen and there are specific instances of both extracellular granules or granular clumps as well as the presence of surface holes or pores. It may be surmised that the granulocytes in nature often liberate different chemical moities through exocytosis and in the event of vigorous exocytotic phenomena smaller holes or pores on plasma membrane may ultimately lead to the formationof crater like or micro-pilar orifices. The (3) third variety of haemocytes observed in *L. marginalis* is unique with characteristically elongated rope-like cylindrical pseudopodia that are polar in nature. These fibrocytes, as has been coined in this present study seems to be hyperactive with their prolonged filipods and take active part in cellular-grouping. The fourth (4) component of haemolymph corpuscles are characterised by their round configurations, strikingly smooth surface and less varieties of pseudopodial processes. In the present investigation the SEM observations have been proved to be significant in terms of classification of these cells and portray the dramatic events through which these cells in general pass towards the formation of a cellular aggregate or clot as the case may be.

A strikingly new observation relates to the demonstration of extra-cellular particulate or amorphous substances which frequently appear along with the different haemolymph cells of *L. marginalis*. Such extra-cellular substance presumably originates by the dissolution of several granules which are exocytosed by the granulocytes or by cell lysis. The syncitial profiles of the haemolymph cells of this bivalve make one assume the presence of some of the factors in the haemolymph itself that are responsible for the collapse of the plasma membrane.

Selected References

Agris, P.F. (1978). Biomolecular structure and Function. Academic Press, New York.

Ambrose, E.J., Batzdorf, U., Osborn, J.S. and Stuart, P.R. (1970). Sub-surface structures in normal and malignant cells. Nature **227** : 397.

Bessis, M. and Weed, R.I. (1972). Preparation of red blood cells for SEM, a survey of various artifacts. SEM IITRI, p. 289.

Cheng, T.C. and Foley, D.A. (1972). A scanning electron microscope study of the cytoplasmic granules of *C. virginica* granulocytes. J. Invertebr. Pathol. **20** : 372.

Narain, A.S. (1972). Formed elements of the blood of the freshwater mussel, *Lamellidens corrianus*. J Morphol. **137**(1) : 63.

Pal, S.G. (1975). Animal cell in the scanning electron microscope. Ind. Biol. **7** : 1.

□

A FOCUS ON ACQUIRED IMMUNODEFICIENCY SYNDROME, TRACKING AN EPIDEMIC

Dipak Kumar Som

Department of Zoology, Hooghly Mohsin College, Chinsurah, Hooghly, West Bengal

From the year 1981 onwards a new virus, Human Immunodeficiency Virus attention as it is associated with the disease complex called Acquired Immunodeficiency Syndrome (AIDS) AIDS is on of the most prevalent infectious diseases in the human population concern about HIV infection is particularly great because virtually all infected individuals eventually progress to AIDS, which has a 100% fatality rate. The HIV belongs to the most interesting and complex family of animal viruses, the *retroviruses* (retro means "backward") Retroviruses are RNA viruses, but they replicate by means of a **DNA intermediate** using the enzyme reverse transcriptase. This DNA becomes integrated into the host chromosome in the manner of a temperate virus. The HIV again as a member of butivirus group ("buti" means slow) contain more complex genomic organization than other retroviruses and encodes a number of regulatory gene products viz., tat, rev, net, vpr, vif, vpn etc. in addition to the standard gag, pol and env genes. These enables them to switch between latent and lytic infection strategies.

Lymphocytes are the most prevalent mammalian cell types involved in the antigen-specific immune responses. Of the two main types B lymphocytes with antigen exposure divide into memory cells and plasma cells. Plasma cells synthesize antibodies responsible for humoral immunity. But the situation with T-cells is more complex. They have antigen-specific T-cell receptors (TCRs) on their surface. Two major subpopulation of T-cells have been identified which are distinguished from each other by the presence of specific cell surface proteins called CD4 or CD8. CD4 class of T lymphocytes includes two functional subsets : T_H or T helper which stimulate B lymphocytes to produce large amount of immunoglobulin and T_D or T delayed type hypersensitivity cells, which participate in cell-mediated reactions with taking no help from B cells. HIV has specific capacity to infect CD4 class of T cells. Uptake of HIV by CD4 cells is governed by the interaction of HIV protein gp120 and the CD4 molecule on T host cells. In cases of clinical AIDS, CD4 lymphocytes mainly T_H cells are greatly reduced in number. However unlike lytic animal viruses, HIV usually does not immediately kill and lyse its host cell. The newly formed viral cDNA integrates into host chromosomal DNA and exists as a provirus. It can remain in a latent state for long periods. Eventually, however, productive virus synthesis occurs and new HIV particles are produced and released from the CD4 cell destroying the host cells.

Destruction of CD4 cells is accelerated by the infected T cells during the processing of HIV antigens. Such cells embed viral gp120 from HIV particles on their cell surfaces. The embedded gp120 on the infected cells then sticks to uninfected cells by binding to the CD4 molecules. Thus numerous cells of each type fuse to produce multinucleate giant cells called *Syncytia*. One HIV-infected T cell may eventually bind and fuse with upto 50 uninfected T cells. The syncytia forming T cells shortly lose immune function and die. In a normal human CD4 cells constitute about 70% of the total T cell pool, in AIDS patient, the number of CD4 cells steadily decreases and by the time opportunistic infections sets in, CD4 cells may be almost absent. As CD4 declines in number, there is a concomitant loss in the cytokines which leads to gradual reduction in all types of lymphocytes. B cells become unable to be stimulated in absence of T_H cells and antibody production declines. The most common AIDS associated opportunistic infections include pneumonia (by protozoa *Pmumocystis carinii*), cryptosporidiosis (by protozoa *Cryptosporidium* sp.), toxoplasmosis (protozoa *Toxoplasma gondii*), funsal infections by *Cryptococcus neoformans, Candida albicans* etc., viral infections due to *herpes, tuberculosis,* mycobacterium and enteric helminthic infections due to *Strongyloides stercoralis.* There is still no effective vaccine for HIV and the genetic variability of HIV has thus far hampered the development of an AIDS vaccine. Likewise, the few drugs that inhibit HIV multiplication viz. Azidothymidine (AZT, ZDV or Zidovudine), ddC (Dideoxycytidine), ddI (Dideoxyinosine), Interferon etc. are also toxic to the host. Since 1981, the number of new AIDS cases in the United States has risen dramatically nearly every year allover the world. Most cases of AIDS result from sex with an infected partner or injection from a unsterilized hypodermic needle. The most effective way to combat AIDS is educating people to avoid infection. The AIDS epidemic is bound to get worse, because AIDS education has not yet had much effect on the behaviour of people at risk of contracting AIDS.

Selected References

Scientific American (Special Issue on AIDS). (1988). **259**(4) : 88-97.

Fan, H., Conner, R.F. and Villarreal. (1994). The Biology of AIDS. By Jones and Bartlett Publishers, USA.

Stine, G.J. (1996). AIDS update 1996. Prentice-Hall, Englewood Cliffs, NJ.

World Health Organization (1996). World Health Report '96. WHO, Geneva. A survey of Infectious diseases throughout the entire world.

Madigan, M.T., Martinko, J.M. & Parker Jack (1997). Brock Biology of Microorganisms. Prentice Hall International, Inc. London.

□

MODERN TECHNIQUE IN SHRIMP FARMING AND ITS IMPACT ON ENVIRONMENT

Subrata Kumar Basu

Department of Zoology, Nara Sinha Dutta College

129, Belilious Road, Howrah -711 101

"Blue revolution" in shrimp culture mostly relies on the physico-chemical factors in the pond water. Various factors in India like suitable land, climatic condition, water quality, availability of brood stock and skilled labour makes it one of the major shrimp exporters in past decade and has earned a good amount of foreign currency by exporting the shrimp abroad. As a result of it more farmers and private sector players diversified their business by investing in shrimp farm to grab a quick return by increasing the stocking density/m^2. And thus level of culture exceeds the carrying capacity of the local environment. High stocking density in semi-intensive to intensive culture system invited serious problems of environmental degradation which resulted in the out break of a viral disease namely, Systemic Ectodermal and Mesodermal Bacculo virus (SEMBV) or white spot disease in *P. monodon* (Wongteerasupaya *et al.*, 1995). Interestingly, it may be the same bacilliform virus which caused the outbreak and resulted in high mortality in cultured kuruma shrimp, *P. japonicus* in Japan (Takahashi *et al.*, 1994).

There are two major factors responsible for degradation of water quality of coastal environment in terms of changes in the bio-diversity of the Coastal ecosystem. These are — Nutrient - laden effluent and suspended solids. Some of the common impacts of commercial Shrimp farming area discussed below :

A) Impact on land resources

i) **Loss of agricultural land** by convertion into shrimp firms to obtain maximum return.

ii) **Salination of soil and ground water** is increased due to the introduction of Shrimp culture in rice field which may render rice production in future.

iii) **Subsidence of coastal land** is found in Taiwan upto 3 mt. due to upliftment of fresh ground water during summer in shrimp pond.

iv) **A threat of mangrove**

Less than 5% of global mangrove resources had been lost to shrimp farming by 1988 (Phillips *et al.*, 1993). In the Phillipines almost 50% of mangrove was converted into aqua culture pond between 1951 to 1988 (Primavera - 1996). Although shrimp farming has been responsible for some loss (7% globally) but most of it is probably as a result of over exploitation of charcoal, poles and fuel wood. Besides all these, expert opinions to the fact that mangroves are not suited

for shrimp farming on account of acid sulphate soil, thus destruction of mangrove forest because of shrimp farming is out of question.

B) Impact on water resources

i) Farm discharge

Effluents from hatcheries and shrimp farm can be a potential cause for nutrient enrichment, eutrophication and contamination by residual biocides of natural water. And shrimp farm waste could stimulate the growth of a toxic phytoplankton known as *Gymnodinium*, which are harmful to the shrimp itself.

ii) Sedimentation

Production of biodeposition like heavy load of suspended solids and coarse sand with high level of organic matter could affect the coastal benthic ecosystem by decreasing oxygen and increasing hydrogen sulphide may ultimately cause obstruction to the flow of water system.

And all these have become a matter of concern for environmentalists.

However, these problems can be overcome through proper planning and sound technical management stratagies like improvement and introduction of -

i) **Long drainage canal** introduction with sediment trapping is required to remove the sediment load.

ii) **Biological treatment** of effluent by filter feeding mussels or oyesters in a bio-pond help to reduce the phytoplankton population. *Gracilaria algae* is also cultured in the same biopond to reduce nutrient in water and also reduce high contents of ammonia, nitrate and nitrite from the culture water.

iii) Closed recycle culture system

The biopond treated water can be reused in the shrimp culture pond again instead of releasing it into the environment (Creek). Thus closed recycling system prevents the environmental degredation as well as ensures the crop success against disease threat.

Selected References

Phillipps, M.J., Kwei Lin, C. and Beveridge, M.C. (1993). Shrimp culture and the Environment : Environment and Aquaculture in Developing Countries. ICLARM Conference Proceedings No. 31, 359 P, Manila, Philippines.

Primavera, J.H. (1996). Environment friendly aquaculture and rehabilitation in mangrove ecosystems. World Aquaculture 96. Annual meeting of the World Aquaculture Society. Jan. 29 - Feb. 2, Bangkok, Thailand.

Takahashi, Y., Itami, T., Kondo, M., Maeda, M., Fuji, R., Tomonaga, S., Supamattaya, K. and Boonyaratpalin, S. (1994). Electron microscopic evidence of bacilliform virus infection in

Kuruma Shrimp (*P. japonicus*). Fish Pathology, **29**(2) : 121-125.

Wongteerasupaya, C., Vickers, J.E., Sriurairatana, S., Nash, G.L., Akarajamorn, A., Boosaeng, V., Panyisn, S., Tassanakajon, A., Withyachumnarnkul, B. and Flegel, T.W. (1995). A non-occluded systemic baculovirus that occurs in cells of ectodermal and mesodermal origin and causes high mortality in the black tiger prawn *P. monodon*. Diseases of Aquatic Organisms, **21** : 69-77.

□

PROCESSING OF PRAWNS IN THE FREEZING PLANTS

Debi Prosad Nag Chowdhury

Ram Krishna Mission Sikshanamandira,

Belurmath, Howrah, West Bengal

From the fisheries point of view, the prawns occupy one of the most significant positions to the Zoologists. Because of their highly nutritive value and relishable taste, the prawns are greatly preferrd by the peoples of many countries. In West Bengal and Bangladesh, the prawns are generally regarded as 'fish' and are called by 'Chingri-machh' and from this, it is very clear that the importance of prawns is not less in any way than that of fish.

The researches on the taxonomy, biology, culture and processing of prawns were started many years ago in a number of countries and are going on with much improvement (Raman, 1968; Jhingram, 1975; Kuriyan and Sebastian, 1976; Mohammad, 1978).

For the ever increasing demand of prawns in the foreign countries, prawn industries also have been developed much in India as well as in Bangladesh. The prawns are exported in frozen condition and a series of steps are adopted in the freezing plants for processing of prawns.

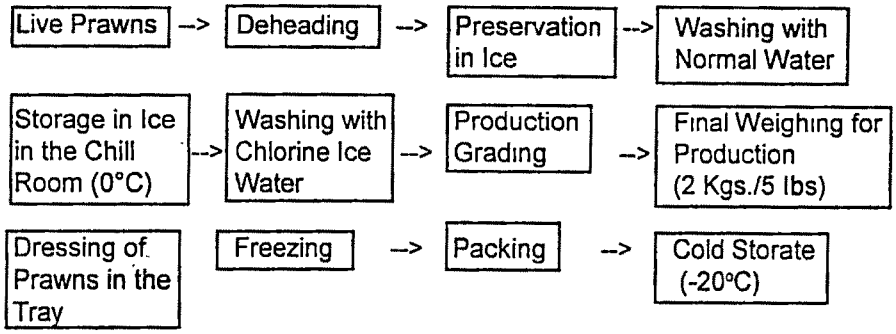
Processing Principle

The processing ust be scientific, i.e., the processing work should be done in such a way that no bacterial and other harmful effect can affect the raw materials and the product must retain its freshness till it reaches to the consumers.

Processing Method

The processing of prawns as observed in the freezing plants of Bangladesh involve the different steps which are shown by a flow-sheet :

Flow Sheet of Processing of Prawns in Freezing Plants



Species of Exportable Prawns

1. *Macrobrachium rosenbergii* (de MAN)
2. *Penaeus monodon* (FABRICUS)
3. *Penaeus indicus* (MILNE-EDW)

Washing with Chlorine-ice water

The head-off prawns are transferred from the Chill room into the processing room. The prawns are then washed with Chlorine-ice-water made by adding bleaching powder with ice water. In some freezing plants, "Sendo-Keep" powder is used to make the Chlorine-ice-water in lieu of bleaching powder. One teaspoonful of "Sendo-Keep" powder mixed with 15 gallons of ice-water makes the Chlorine-ice-water.

"Sendo-Keep" powder is a high qualtiy preservative for Sea foods and it is imported from Japan.

Chemical composition of "Sendo-Keep" powder

Chlorine T - 35%, sodium pyrophosphate - 6%, Sodium polyphosphate - 15%, Sodium Citrate - 24%, Methyl cellulose - 3%, Burnt alumn - 11%, Sodium Carbonate - 3%, Sodium bicarbonate - 3% (Total - 100%).

The washing of prawns with Chlorine-ice-water is done three times in three washing tanks placed side-by-side. The prawns are washed int he first tank and these are transferred int the second tank and then to the third, each containing the Chlorine-ice-water.

Production grading

After washing in Chlorine-ice-water, the prawns are transferred ont he grading table. Several buckets, made of either tin or polythene, are arranged on the table in the systematic way marked by the grades from uper to lower, i.e. U/5, 5/10, 11/15 and so on upto 36/40 and 41/50, 51/60 upto 81/100 head-off prawns/pound. There is another grade named 'P&D' which means Peeled and Deveined (no countation is maintained).

Final weighing or production weighing

The prawns are finally weighed by keeping them in the polythene pan and by placing the pan on the stand-balance. The fresh water Galda (*M. rosenbergii*) is weighed in the scale of 5 lbs. and Sea water Bagda (*P. monodon*) and white Sea water Chaka (*P. indicus*) are weighed in the scale of 2 Kgs. Galda is mainly exported to U.S.A., U.K. and Holland, who want the packing of 5 bbs. of prawns and the Sea water Bagda and Chaka, are mainly exported to Japan, who wants the packing of 2 Kgs.

Dressing of prawns in the tray

After final washing, the prawns of each 2 Kgs. or 5 lbs. are dressed in a small tray, made of tin. A polythelene thin paper is first stretched on the tray. The measurement of each tray is 12" x 8" x $2^1/_2$". The measurement of each polythelene paper is 28" x 20". The prawns are arranged in two longitudinal rows, but in two or more layers in such a way that the tails of the prawns of two rows must be placed face to face and the broad portion of the body must be kept towards the sides of the tray.

When the arrangement of the prawns in each small tray is completed, the polythelene paper containing the arranged prawns is lifted up from the small tray and placed in one of the chambers of 5-chamereed or 3-chambered long tray.

When all the chambers of the long tray are filled up by the prawns, stretched on polythelene paper, the ice water is poured on the prawns of each chamber in such a way that all the prawns must be remained sunken in ice water and the water must be raised upto the edge of the tray. Then all the sides of the polythelene paper are folded to cover the sunken prawns and the dressing of prawns in tray is thus completed. All the works of the dressing are generally done by the female workers. The 3-chambered or 5-chamberd long tray is used depending upon the size of the plate freezer. In "air-blast freezer", no long tray is used and in that case, the small trays are arranged in rows on the different shelves of the freezer.

Freezing

There are some plates or shelves in the plate freezer. The trays with dressed prawns are inserted into the plate freezer and placed on the shelves side by side. 3 to 5 long trays can be

placed on one shelf and this depends upon the size of plate freezer. After the insertion of the trays inside the plate freezer, the doors of the freezer are closed and the machine is operated. By the hydrolic press system, the plates are compressed either downwards or upwards, the different techniques adopted in different plate freezer, and simultaneously the temperature of the freezer must be regulated from -37°C to -40°C. By the pressure of the plates the prawns with ice water are also compressed. The freezer is kept undisturbed and within $2^1/_2$ - 3 hours, the ice water with prawns in each chamber of the tray is converted into rectangular block of ice within which the prawns remain forzen. The the freezer is unloaded and the trays are also unloaded. Thus, the freezing of prawns in plate frezer is completed.

Storing in Cold Storage

After final packing, the master cartons containing some "Inner Cartons" are transferred immediately into the cold storage within which the temperature is maintained from -20°C to -22°C. If the regulation of temperature in the cold storage is kept undisturbed, the products must remain fresh for several months and even for years together. Thus, the products of frozen shrimps are ready for shipment for export.

Selected References

Jhingran, V.G. (1975). Fish and Fisheries of India. Hind. Pub. Corp. India. 1-954.

Kuriyan, C.V. and Sebastian, V.O. (1976). Prawns and Prawn Fisheries of India. Hind. Pub. Corp. India. 1-280.

Mohammad, K.G. (1978). Supply of raw shrimps and utilization of capacity in shrimp processing plants. Seminar on "Culture of Shrimps in Khulna Region", Export Promotion Bureau, Khulna.

Raman, K. (1968). On an experiment in Prawn-cum-Tilapia culture in paddy field. Indian J. Fish. **15**(1,2) : 884-897.

□

VARIOUS PATHWAYS OF REGULATION OF GENE EXPRESSION

G.C. Sadhukhan

Department of Zoology, Vidyasagar College

39, Sankar Ghosh Lane, Calcutta-700 006

Cell is very much systamic and economic. It turns on the expression of gene(s) whenever its product is needed to the cell, while turns off the expression as the need is over. Thus some kind of regulation is there to control the gene expression. Regulation may be effected following various pathways at various levels of expression, some of them are as follows :

A) **Regulation by interaction of transcription of transacting factors and cis-acting sites** :

Here, regulation takes place at transcriptional lavel Regulatory unit comprising a set of coding (structural) gene(s) and non coding genes (promoter and operator) is called an *operon.* Structural genes when many are contiguous, and on their upstream is located the promoter. Operator is in between promotor and structural genes. Promoter and operator are cis-acting genes The expression of the operon is under the control of a trans-acting coding gene called regulator, which may be nearer to or some distant away from the operon. Regulatory protein of regulator gene may inactivate RNA polymerase binding to promotrr and accordingly prevent transcription of operon (nagative control), or it may activate RNA polymerase binding to turn on transcription (positive control). In nagative control, Regulatory Protein (Repressor) in absence of inducer binds to operator and prevents RNA polymerase binding to promoter and thus turns off operon transcription. While in presence of effector molecule (inducer) the conformation of repressor changes and thus detaches from operator. RNA polymerase in this state binds to promoter and turns on transcription Such operon is called an Inducible operon (e.g. lac-operon). While in some operons, regualatory operator to turn off transcription; such operon is called repressible operon. In positive control, the regulatory protein binds to some region on promoter and stimulates RNA polymerase binding to turn on transcription.

Thus, gene regulation 'turning on' and turning off the operon expression) is a consequence of interaction between trans-acting factor and cis-acting sites.

However, the repressor molecules (10 to 12 molecules/cell in uninduced state) remain stored in cell rarely free in cytoplasm but on DNA at random sites. Only one of them that remains bound to specific site, the operator, while rest of the molecules remain bound on unspecific sites on DNA in uninduced state. All of them remain bound at unspecific sites in induced state making operator free.

B) **Regulation by attenuation** .

It occurs at transcriptional level in those operons involved with aminoacid biosynthesis. Here the operon contains a leader sequence on the upstream of structural genes. The leader transcipt forms alternative secondary structures of antiterminator and terminator loops, any one at a given time. Antiterminator allows to go on transcription of operon through sturcutural genes, while terminator causes premature termination of operon transcription before it reaching the startpoint of structural genes. The choice of which structure to form is controlled by the movement of ribosome during its translation of a short leader peptide sequence, that includes codon(s) for the aminoacid(s) that are the product of the operon-system. In presence of aa~tRNA bearing such aminoacid, the ribosome translates the peptide and attains a position on transcript that disallows the formation of antiterminator but the terminator and thereby preventing transcription of structurral genes. While in absence of aa~tRNA, the ribosomal movement stalls and allows the formation of anitterminator but not the terminator and thereby allows transcription to go on through structural genes of operon (e.g. trp-operon).

Attenuation, however, may also be regulated by a protein that bind to RNA either to stabilize or destabilize the terminator hair-pin. In trp-operon of *B. subtilis*, the Mtr B protein binds to the leader of the transcript to promote formation of terminator hair-pin, and thus to function as a transcription terminator. This protein is activated by tryptophan. While the bgl G protein binding to a sequence in the 5' nontranslated leader of the transcript of bgl operon sequesters part of the sequence required for formation of an intrinsicterminator hair pin; and thus serves as an antiterminator.

C) **Autogenous control** :

This takes place at translational level. Here repressor function is served by a protein that binds to a target region on mRNA to prevent ribosome binding and thus not to occur the initiation of translation, e.g. Reg A protein of T_4 phage, R_{17} coat protein of RNA phage etc. Many of them follow autogenous control, e.g. r-proteins (ribosomal proteins) when in excess than rRNA, such protein binds to m RNA at ribosomal binding site to prevent translation of any more r-proteins.

D) **Unusual nucleotide (P) PP Gpp as transcription regulator** :

This is found in bacteria during stringent response, where bacteria due to short supply of aminoacids to sustain protein synthesis shut down a wide range of activity. Due to lack of amino acid, unchanged tRNA sitting on A-site of ribosome stalls its movement and triggers an idling reaction of ribosome. This reaction leads to the synthesis of (P) PP Gpp by stringent factor (= (P) PP Gpp synthetase). (P) PP Gpp inhibits the initiation of transcription at the promoters of operons coding for rRNA. PP Gpp also inhibits the elongation of transcription, done by pausing RNA polymerase.

E) **Small RNA molecules as regulators** :

Such small RNA molecules are independently synthesized and diffuse to a target m-RNA sequence. The regulator RNA molecules regulate gene expression by complementarity with its target m RNA, at which it can form a double stranded region. Such RNAs that block function of an m RNA by virtue of complementarity with it are called antisense RNA. Antisense RNAs show at least 3 situations : (i) Antisense RNA may bind to an m RNA to occlude the site for ribosome binding and thus prevent initiation of protein synthesis; (ii) Antisense RNA may also directly destabilize a target m RNA by binding it to form a duplex region that is very susceptible to endonuclease activity; and (iii) Antisense RNA may bind to a transcript to mimic a terminator and thereby causes premature transcription termination. e.g. Omp F gene of *E. coh.*

Selected References :

Jacob, F. and Monad, J. (1961). Genetic Regulatory mechanism in the synthesis of Protein. J. Mol. Biol. **3**, 318-356.

Miller, J. and Reznikoff, W. (1978). The operon Cold Spring Harbor Laboratory, New York.

Yanofsky, C. (1981). Attenuation in the control of expression of bacterial operons Nature **289**, 751-758.

Nomura, M. *et al.* (1984). Regulation of the synthesis of ribosomes and ribosomal components. Ann. Rev. Biochem. **53**, 75-117.

Green, J., Pines, O., and Inouye, M. (1986). The Role of antisense RNA in gene regulation. Ann. Rev. Biochem. **55**, 569-597.

Cashel, M. and Rudd, K.E. (1987). The stringent response. In *E. coli* and *S. typhimurium;* Ed. F.C. Neidhardt, American Society for Microbiology, Washington DC, 1410-1429.

Gold, L. (1988). Post transcriptional regulatory mechanisms in *E. coli.* Ann. Rev. Biochem. **57**, 199-233.

Condon, C., Squires, C. and Squires, C.L. (1995). Control of rRna transcription in *E. coli.* Microbiol. Rev. **59**, 623-645.

□

MICROCIRCULATION OF LIVER : PORTAL HYPERTENSION AND CLINICAL IMPLICATIONS

T. K. Banerji
Professor, Department of Anatomy & Neurosciences
University of Texas Medical Branch
Galveston, Texas 77555-1069, USA

A) Anatomical position

B) Structure of Liver -

1) Capsule - Glisson's capsule
2) Liver parenchyma
3) Liver lobule - (a) Classical lobule, (b) Portal lobule
4) Portal circulation of liver
5) Portal vein
6) Hepatic artery — Portal Triad
7) Bile duct
8) Portal triad and central vein
9) Sublobular vein
10) Hepatic vein
11) Hepatic sinusoids
12) Bile canaliculus
13) Space of Disse
14) Apical microvilli of hepatocytes
15) Kupffer cells

C) Functions of Liver -

1) Function of bile
2) Storage - Aminoacids, glycogen, fate
3) Synthesis of clotting factors, globulius, serum albumin
4) Other proteins
5) Detoxification
6) Degradation of Drugs and hormones
7) Metabolism of protein, carbohydrate and fat

D) Portal hypertension -

1) Obstruction of blood flow
2) Spleenomegaly
3) Esophageal varices
4) Jaundice
5) Formation of micronodules in liver
6) Fatty charges of liver
7) Malabsorption
8) Hypoglycemia
9) Encephalopathy

E) Surgical Treatments

F) TIPS procedure

TIPS = Transjugular intrahepatic portosystemic shunt

Suggested readings :

A Textbook of Histology. W. Bloom and D.W. Fawcett, W.B. Saunders Company, London, 1994.

Brauer, R.W. Liver circulation and function. Physiol. Rev. **43** : 115-126, 1963.

Rappaport, A.M., Z.J. Borowy, W.M. Loughead and W.N. Lotto : Subdivision of hexagonal liver lobules into a structural and functional unit : role in hepatic physiology and pathology. Anat. Rec. **119** : 11-16, 1954.

□

BASIC PRINCIPLES OF ENDOCRINOLOGY : THE PITUITARY GLAND

T. K. Banerji
Professor, Department of Anatomy & Neurosciences
University of Texas Medical Branch
Galveston, Texas 77555-1069, USA

I. Basic Principles of Endocrinology : Main Points

A) Endocrine Glands

1) Structural specializations - [Ductless, Epitheliod, Highly vascularized, Fenestrated endothelium]
2) Functional specializations - Secrete hormones of diverse kinds
3) Feedback control
4) Target glands
5) Circadian rhythms of hormones
6) The pre- pro-hormone concepts
7) Ectopic hormone production
8) Ectopic hormone production in cancer

B) Pituitary Gland

1) Anatomic location - Sella turcica; sphenoid bone
2) Development - i) Downgrowth of diencephalon - Neurohypophysis
   ii) Evagination from oral ectoderm - Adenohypophysis

3) Adult structure of the gland
   a) Neurohypophysis - i) Median eminence
      ii) Infundibular stalk
      iii) Infundibular process

   b) Adenohypophysis - i) Pars distalis
      ii) Pars tuberalis
      iii) Pars intermedia

4) Histomorphology - Adenohypophysis [Acidophilis, Basophilis, Chromophobes]
- Neurohypophysis [Nerve fibres, Pituicytes]

5) Hormones :
(a) Adenohypophysis - Growth hormone (acidophilis)
(Pars distalis) Prolactin (")
Adrenocorticotropin (Basophils)
Thyroid stimulating hormone(")
Gonadotropin (LH + FSH) (")
Pars intermedia (poorly developed in human)
- Melanocyte stinulative hormone
Pars tuberalis - not well understood
(b) Neurohypophysis - Oxytocin, Vassioressub ir ADH

6) Hypophyseal portal system - Neurorascular link

7) Hypothelamic Releasing / Inhibiting Factors (or Hormones)

All pituitary hormone productions are modulated by releasing and/or inhibiting factors synthesized in the hypothalamus.

Suggested readings

Comparative Vertebrate Endocrinology, P.J. Bentley, Cambridge University Press, 1998.
Guillemin, R. and Burgus, R. The hormones of the hypothalamus. Sci.Am. **227** : 24-33, 1972.
General Endocrinology, C.D. Turner and J.T. Baguara, W.B. Saundar Co., 1976.
Textbook of Endocrinology, R.H. Williams, W.B. Saunders Company, London, 1974.
Recent studies on the chemistry of human growth hormone. Colloq. Int. C.N.R.S. **177** : 175-179, 1969.

Index : Resource Persons

Name	Page	Name	Page
A.S. Mukherjee	1	Amalesh Choudhury	95
A.K. Das	3	B.R. Maiti	98
R.N. Chatterjee	6	Malaya Gupta	104
M.L. Bhowmik	8	M.S. Ghoshal	108
B.N. Bhattacharyya	13	Amar Bhaduri	117
S.G. Pal	16	N.C. Datta	119
Shelly Bhattacharyya	17	Tushar Kanti Ghosh	123
Sanjib Chakraborty	20	S. Chatterjee	126
D.K. Nanda	22	Swadesh Duttagupta	128
D.N. Jana	23	Pradeep Das	131
Samiran Chakrabarti	27	S.K. Bhattacharya	135
Biswatosh Sengupta	30	Manas Ranjan Ray	138
P.K. Maiti	34	S.P. Bhattacharyya	140
J.N. Rudra	37	Subir K. Ghosh	142
Tapan Kumar Pal	42	Bireswar Banerjee	147
N.B. Chatterjee	45	D.P. Haldar	150
K.D. Mukherjee	49	Twisha Lahiri	152
Swapan Kr. Das	52	Soumen Kr. Maitra	155
Samar Chakrabarti	62	A.K. Ghosh	163
A.K. Bandyopadhyay	65	A.K. Ghosh	165
S.K. Dasgupta	73	A. Kaviraj	170
T.N. Ghosh	79	Gourisankar Sa	173
K.K. Misra	83	Arun K. Ray	177
Timir Baran Samanta	86	A.P. Nandi	178
D. Mandal	88	Bikash Chandra Pal	181
J.J. Ghosh	92	P.K. Sen-Sharma	183

Name	Page	Name	Page
J.N. Rudra	185	Lalita Das	245
N.C. Sukul	189	N. Ghorai	246
A. Nandy	191	Dhananjay Mishra	247
A.Nandy	196	Chandana Naskar	248
Pranabes Sanyal	203	Tushar K. Mukhopadhyay	249
R.K. Poddar	221	Prasun Kr. Banerjee	251
C.K. Manna	222	Madanmohan Ghosh	252
G. Majumdar	224	Swagata Chattopadhyay	254
Subrata Roy	228	Chinmoy Sekhar Sarkar	256
N.C. Datta	231	Papiya Lahiri	257
D.V. Krishnam Raju	235	Snigdha Dass	259
B.C. Behera	237	Dipak Kumar Som	261
Anup Duttagupta	238	Subrata Kumar Basu	263
Swapan Rej	240	Debi Prosad Nag Chowdhury	265
N.C. Maity	241	G.C. Sadhukhan	269
Shekhar Mukhopadhyay	243		